PROCEEDINGS OF THE

Twenty-Second Annual Convention

OF THE

American Railway Bridge and Building Association

HELD AT

BALTIMORE, MARYLAND

October 15-17, 1912

REPORTS IN THIS ISSUE

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C. A. Lichty, Secretary
226 W. JACKSON BOULEVARD
CHICAGO, ILL.

The Twenty-third Annual Convention
will be held at Montreal, October 21-23
1913

PROCEEDINGS OF THE

Twenty-Second Annual Convention

OF THE

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

BALTIMORE, MD.

OCTOBER 15-17, 1912

Official Badge

PRICE, ONE DOLLAR

BRETHREN PUBLISHING HOUSE
ELGIN, ILLINOIS
1913

A. E. KILLAM

INTERCOLONIAL RAILWAY OF CANADA

President, 1912-13

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OFFICERS FOR 1912-13

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THE EXECUTIVE COMMITTEE

Consists of the Officers and the following Members:

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C. E. SMITH, Missouri Pacific Ry.,.........................St. Louis, Mo.
S. C. TANNER, Baltimore & Ohio R. R., ...Baltimore, Md.
LEE JUTTON, Chicago & Northwestern Ry., ...Chicago, Ill.

PAST PRESIDENTS

1891-92	O. J. Travis,	Pinehurst, Wash.
1892-93	*H. M. Hall,	Ohio & Mississippi Ry., Olney, Ill.
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1894-95	G. W. Andrews,	Baltimore, Md.
1895-96	W. A. McGonagle,	D. M. & N. Ry., Duluth, Minn.
1896-97	James Stannard,	Kansas City, Mo.
1897-98	*Walter G. Berg,	Lehigh Valley R. R., New York City
1898-99	J. H. Cummin,	Bay Shore, N. Y.
1899-00	A. S. Markley,	Chicago & Eastern Illinois R. R., Danville, Ill.
1900-01	W. A. Rogers,	37 W. Van Buren St., Chicago, Ill.
1901-02	W. S. Danes,	Wabash R. R., Peru, Ind.
1902-03	B. F. Pickering,	Boston & Maine R. R., Salem, Mass.
1903-04	A. Montzheimer,	Elgin, Joliet & Eastern Ry., Joliet, Ill.
1904-05	C. A. Lichty,	Chicago & Northwestern Ry., Chicago, Ill.
1905-06	J. B. Sheldon,	N. Y. N. H. & H. R. R., Providence, R. I.
1906-07	J. H. Markley,	Toledo, Peoria & Western Ry., Peoria, Ill.
1907-08	R. H. Reid,	L. S. & M. S. Ry., Cleveland, O.
1908-09	J. P. Canty,	Boston & Maine R. R., Boston, Mass.
1909-10	J. S. Lemond,	Southern Ry., Charlotte, N. C.
1910-11	H. Rettinghouse,	C. & N. W. Ry., Mason City, Ia.
1911-12	F. E. Schall,	Lehigh Valley R. R., So. Bethlehem, Pa.

*Deceased.

SUBJECTS AND COMMITTEE APPOINTMENTS FOR 1913

1. Water Supply.

   C. R. Knowles, Chairman, I. C. R. R., Chicago.
   J. Dupree, 5608 So. Aberdeen St., Chicago.
   John Ewart, B. & M. R. R., Boston, Mass.
   J. B. White, C. & N. W. Ry., Boone, Ia.
   Guy Gordon, C. R. I. & P. Ry., Little Rock, Ark.
   C. F. Warcup, G. T. Ry., St. Thomas, Ontario.

2. Track Scales.

   A. M. Van Auken, Chairman, F. E. C. Ry., St. Augustine, Fla.
   C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
   R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
   H. M. Jack, I. & G. N. R. R., Palestine, Tex.
   G. H. Soles, P. & L. E. R. R., Pittsburgh, Pa.

3. Equipment and Tools for Bridge Gangs.

   A. Yappen, Chairman, C. M. & St. P. Ry., Chicago.
   R. H. Reid, L. S. & M. S. Ry., Cleveland, O.
   F. O. Draper, I. C. R. R., Chicago.
   J. A. Killian, Sou. Ry., Charlotte, N. C.

4. Concrete Culverts and Various Kinds of Pipe for Culverts.

   L. D. Hadwen, Chairman, C. M. & St. P. Ry., Chicago.
   O. F. Dalstrom, C. & N. W. Ry., Chicago, Ill.
   C. J. Scribner, C. B. & Q. Ry., Chicago.
   W. L. Rohbock, W. & L. E. R. R., Cleveland, O.

5. Heating, Lighting and Ventilating of Roundhouses and Shops.

   G. W. Hand, Chairman, C. & N. W. Ry., Chicago, Ill.
   M. A. Long, B. & O. R. R., Baltimore, Md.
   G. H. Jennings, E. J. & E. R., Perry, Iowa.
   E. E. Clothier, C. M. & St. P. Ry., Perry, Iowa.

6. Sewers and Drains.

   R. O. Elliott, Chairman, L. & N. R. R., Nashville, Tenn.
   A. F. Miller, P. R. R., Chicago, Ill.
   E. C. Morrison, Sou. Pac. Co., San Francisco, Cal.
   K. Peabody, N. Y. C. & H. R. R. R., New York City.

7. Motor Cars for Bridge Gangs.

R. C. Young, Chairman, L. S. & I. Ry., Marquette, Mich.
A. Montzheimer, E. J. & E. Ry., Joliet, Ill.
C. H. Fake, M. R. & B. T. R. R., Bonne Terre, Mo.
P. Swenson, Soo Line, Minneapolis, Minn.

8. Temporary Structures for Supporting Tracks During Construction of Permanent Work, Sewers, etc.

W. C. Whitney, Chairman, B. & A. R. R., Boston, Mass.
J. P. Canty, B. & M. R. R., Boston, Mass.
G. Aldrich, N. Y. N. H. & H. R. R., Boston, Mass.
J. B. Sheldon, N. Y. N. H. & H. R. R., Providence, R. I.

9. Concrete Posts, Poles and Signs.

G. E. Boyd, Chairman, D. L. & W. R. R., Scranton, Pa.
F. L. Thompson, I. C. R. R., Chicago, Ill.
A. S. Markley, C. & E. I. R. R., Danville, Ill.

10. Snow Fences.

A. H. King, Chairman, O. S. L. R. R., Salt Lake City, Utah
C. E. King, C. & N. W. Ry., Omaha, Neb.
F. E. King, C. M. & St. P. Ry., Minneapolis, Minn.
Frank Lee, C. P. R., Winnipeg, Manitoba.
C. S. McCully, N. P. Ry., Jamestown, No. Dak.

11. Preservation of Timber.

G. W. Rear, Chairman, Sou. Pac. Co., San Francisco, Cal.
F. D. Beal, 912 Yeon Bldg., Portland, Ore.
F. D. Mattos, Sou. Pac. Co., West Oakland, Cal.
A. J. Catchot, L. & N. R. R., Ocean Springs, Miss.

12. Cattle Guards.

Arthur Ridgway, Chairman, D. & R. G. R. R., Denver, Colo.
Daniel Burke, Sou. Pac. Co., Tucson, Ariz.
D. A. Ballenger, Southern Ry., Greenville, N. C.
J. W. Fletcher, Car. & N. W. Ry., Chester, S. C.
W. V. Parker, C. R. I. & P. Ry., Amarillo, Tex.
H. J. McGrath, I. C. R. of Can., Moncton, N. B.

13. Fire-Resisting Coatings for Timber.

Lee Jutton, Chairman, C. & N. W. Ry., Chicago.
W. H. Moore, N. Y. N. H. & H. R. R., New Haven, Conn.
W. H. Finley, C. & N. W. Ry., Chicago.
C. T. Musgrave, O. S. L. R. R., Idaho Falls, Idaho.
J. S. Robinson, C. & N. W. Ry., Chicago.
E. S. Meloy, C. M. & St. P. Ry., Chicago.

NOMINATIONS.

R. H. Reid, L. S. & M. S. Ry., Cleveland, O.
S. F. Patterson, B. & M. R. R., Concord, N. H.
J. B. Sheldon, N. Y. N. H. & H. R. R., Providence, R. I.
G. W. Andrews, B. & O. R. R., Baltimore, Md.

SUBJECTS.

F. E. Weise, C. M. & P. Ry., Chicago.
C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
W. F. Strouse, B. & O. R. R.
B. F. Pickering, B. & M. R. R., Salem, Mass.

RELIEF.

A. Montzheimer, E. J. & E. Ry., Joliet, Ill.

MEMBERSHIP.

J. B. Gaut, G. T. Ry., Montreal, Que.
J. E. Travis, G. T. Ry., Toronto, Ont.
Frank Lee, C. P. R., Winnipeg, Manitoba.
G. S. Kibbey, M. & St. L. R. R., Minneapolis, Minn.

PUBLICATIONS.

R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
L. D. Hadwen, C. M. & St. P. Ry., Chicago, Ill.
Lee Jutton, C. & N. W. Ry., Chicago, Ill.

ARRANGEMENTS.

Phelps Johnson, Dom. Bridge Co., Montreal, Que.
J. B. Gaut, G. T. Ry., Montreal, Que.

OBITUARY.

J. N. Penwell, L. E. & W. R. R., Tipton, Ind.

Proceedings of the Twenty-second Annual Convention

OF THE

American Railway Bridge and Building Association

HELD IN THE EMERSON HOTEL

Baltimore, Md., October 15, 16 and 17, 1912

MORNING SESSION.

Tuesday, Oct. 15, 1912.

The twenty-second annual convention was called to order at 10 A. M., by President F. E. Schall.

Prayer was offered by Mr. J. N. Penwell.

The President:—Ladies and Gentlemen, Members of the American Railway Bridge and Building Association: As far as I know, this is the first meeting held by this association in Baltimore, and I dare say that many of us know little concerning the city. The gentleman who is to address us now will no doubt enlighten us in regard to the special characteristics of this beautiful city. I now have the pleasure of introducing to you Mr. Robert E. Lee, secretary to the Honorable Mayor of the City of Baltimore.

Mr. Lee:—Mr. Chairman, Ladies and Gentlemen: I am indeed sorry that business of great importance affecting the municipality, made it impossible for the mayor to be personally present with you this morning, as he would have liked to be, but, as you are all practical men doing the world's work each day, you know what it means to be the chief executive of a great city such as this is, and are well aware of the many demands upon his time making it absolutely impossible for him to attend all the functions that he would like to be able to attend. Therefore the duty devolved upon me on this occasion, to welcome to our beautiful city this splendid gathering of my fellow citizens. I see by the back of your program that someone has very prop-

erly and appropriately given you some idea regarding the extent to which our community has blazed the way in many of the important things that affect the progress of our country. I will be relieved, therefore, from going into those details, because, if you look on the back of this little folder, you will find that Baltimore and Maryland have been the pioneers in many historic events and in many of the great events that have so blessed our people and made our country great and prosperous. We have today in this city many things that I think probably would be especially interesting to a gathering of gentlemen whose lifework is that of doing things that the people must have done and cannot do without. There are two sides to nearly all things that one might undertake to argue about. One might doubt whether we should have protection or free trade; or whether our tariff should be revised up or down, but one cannot deny that we must have railroads and bridges and men to build them, in order that this country may grow and prosper.

We are today carrying on as great public improvements as you will find at one time in any city of similar size in the United States. Since the great fire that devastated the entire business district and wiped out the place where we now sit, we have appropriated nearly sixty million dollars in order to beautify our city and make it more healthful and more comfortable for our people to live in. We are building a great sewer system that we claim is the greatest sewer system in any American city. We are laying out a great mileage of streets, some ten million dollars' worth of paving being undertaken at one time, due, in a large measure to the fact that we had the old cobble stone pavement, which has been laid on the streets of our city since its early foundation. We expect to remove all of this within the period of four or five years. Then we have what we call the Falls Way, where we are converting a stream that flows through the city and that has been an eyesore to our people, into one of the great assets of our city, a splendid driveway and a great artery that will help to solve our sewerage problem. And all over the city, if you care to wander, you will find great improvements that will interest practical men who do things. We have other things that will interest you and the ladies. We have a beautiful park system. I think I may say, without successful contradiction, that we have here one of the most beautiful public parks that can be seen anywhere in the United States. It is not as large as some other

parks, but it is larger than many, and it is a natural beauty spot that cannot be surpassed anywhere. In our park system, we have a combined acreage of 2,650 acres, connected by a boulevard that takes you from the southeastern section through all the parks of the city and lands you in the southwestern section. Then we have a great many places of historic interest; the Peabody Institute, the Johns Hopkins University, the Walters Art Gallery and many places that you will find printed on the back of your folder and to which it will not be necessary for me to call your attention. I am glad, to see in this convention, a greater number of the ladies than we ordinarily find in conventions of this kind, and I have thought that probably this is due to the fact that practical men who create wealth always see that they get a little bit for themselves and probably they are able to bring their wives with them.

We are proud of our history. You are standing on a spot almost as historic as any in the Union. Maryland has always given liberally of her brains, her talents and her sons to make the country's history great and grand. You stand within the shadow of the first monument erected to the memory of George Washington. You stand within easy distance of the place where Washington laid down the command of the army and navy of the United States. You stand within sight and easy distance of the place where Francis Scott Key penned his immortal anthem. and you are within a few hours' ride of the western section of our State, where sleeps one of the noblest characters and bravest admirals who ever directed the course of a ship, Winfield Scott Schley. And, my good people, I might go on and detail to you the great historic events that have taken place in our state and the men who have participated in them, but I know you are busy people and will not detain you much longer. We hang out to you the latch key, extending a genuine and cordial welcome and bid you Godspeed in the work you are to perform.

The President:—I am sure we all appreciate the hearty welcome extended by Mr. Lee, and I ask Mr. J. H. Cummin to respond.

Mr. Cummin:—Mr. Lee, in behalf of the members of our association, the ladies, and friends: I want to thank you not only in their behalf, but in my own, for the warm, cordial welcome that you have given us to your city. These men who are members of this association, I can assure you, Mr. Lee, are the most

optimistic group of men you ever had the pleasure of meeting. I don't believe there is one of them but that is even more optimistic than the Irishman who was working on a sky scraper in New York a short time ago. He had been working on the seventeenth floor and accidentally slipped and went down a hatchway. As he was going by the third floor, one of his mates heard him say, "Begorra, I'm all right yet." (Laughter.)

I can assure you, Mr. Lee, that we are glad to meet in Baltimore. This is an association composed of men who have very little spare time. The majority of the members attending these meetings take this as their only vacation during the year. They come here to listen to the reports of the different committees and to discuss those subjects, earnestly striving in every way to better fit themselves for the duties they are called upon to perform, and going home with the feeling that they have added to their knowledge and ability, and are in every way better prepared to work for the company by whom they are employed. They are a body of true, earnest, hardworking men. As I walked through your streets yesterday afternoon, it brought to my mind the first time that I ever saw your city. It was in the dark days of 1861. When we reached Philadelphia twenty rounds of cartridges were issued to each man. At that time, the railroads did not go through your city and we had to disembark at one side of the city, march through and embark on the other side for Washington. Those were indeed dark days, but, as General Fitzhugh Lee said to us at a meeting in Washington just at the close of the Spanish-American war, that year there had been erected a grand, long, broad and noble bridge over the chasm that had existed between the different parts of the country for so many years, and today, in 1912, we can meet in Baltimore or in any section of this country, all living, working and having our being under one flag and that flag the grandest banner that has even been thrown to the breeze by any nation on the face of this earth. (Applause.) Mr. Lee, again I thank you for your kind words and I can assure you that we appreciate your coming here —leaving the many arduous duties that come before you and spending so much of your time with us. (Applause.)

The Secretary:—Before the ladies retire I wish to read a letter from Mrs. Noon. (A letter was then read from Mrs. W. M. Noon, Palatka, Florida, in which she gave the reasons for Mr.

Noon and herself not being able to attend the convention, as they had planned.)

The President:—We will now have a short recess to permit the ladies to retire from the room, after which we will resume our regular order of business.

(Short recess.)

The President:—The first order of business is the roll call, but as we use the card registration system we will not have to go through the formality of calling the roll. The registration showed the following members present:

MEMBERS PRESENT AT THE 1912 CONVENTION.

AAGAARD, P., Supvr. B. & B., I. C. R. R., Chicago.
ALDRICH, G., Supvr. B. & B., N. Y. N. H. R. R., Boston.
ALEXANDER, W. E., Supt., B. & B., B. & A. R. R., Houlton, Me.
ANDREWS, G. W., Inspr. Maintenance, B. & O. R. R., Baltimore.
ARNOLD, F. J., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
BARTON, M. M., Mast. Carp., P. R. R., Philadelphia.
BEARD, A. H., For. Carp., P. & R. Ry., Reading, Pa.
BIBB, J. M., Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
BOWERS, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.
BOYD, Geo. E., Supt. B. & B., D. L. & W. R. R., Scranton, Pa.
BROWNE, J. B., Gen. For. B. & B., K. C. C. & S. Ry., Clinton, Mo.
BRUCE, R. J., Supt. of Buildings, Mo. Pac. Ry., St. Louis.
CANTY, J. P., Supt. B. & B., B. & M. R. R., Boston.
CARDWELL, W. M., Mast. Carp., Wash. Term. Co., Washington, D. C.
CASE, F. M., For. Water Service, C. & N. W. Ry., Belle Plaine, Ia.
CATCHOT, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
CLARK, W. M., Mast. Carp., B. & O. R. R., Pittsburgh.
CUMMIN, J. H., Bay Shore, N. Y.
DECKER, H. H., Eng. Maint., C. & N. W. Ry., Chicago.
DUPREE, Jas., For. Water Service, C. T. H. & S. E. Ry., Crete, Ill.
EGGERS, C. H., Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
EGGLESTON, H. H., Asst. Mast. Carp., B. & O. C. T. R. R., Blue Island, Ill.
EGGLESTON, W. O., Br. Inspr., Erie R. R., Huntington, Ind.
ELLIOTT, R. C., Supvr. B. & B., L. & N. R. R., Nashville, Tenn.
ELWELL, H. A., Supvr. B. & B., C. G. W. R. R., Clarion, Iowa.
ETTINGER, Chas., For. Painter, I. C. R. R., Chicago.
EWART, John, Supt. Water Service, B. & M. R. R., Boston.
FLINT, C. F., For. B. & B., C. Vt. R. R., St. Albans, Vt.
GEHR, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind.
GRIFFITH, F. M., Supvr. B. & B., C. & O. Ry., Covington, Ky.
HARWIG, W. E., Supvr. B. & B., L. & N. E. Ry., Bethlehem, Pa.
HOPKE, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
HUDSON, B. M., Gen. For. B. & B., T. & B. V. Ry., Teague, Tex.
HUNCIKER, John, For. Br. Erection, C. & N. W. Ry., Chicago.
JACK, H. M., Gen. For. B. & B., I. & G. N. R. R., Palestine, Tex.
JEWELL, J. O., Supt. B. & B., C. T. H. & S. E. Ry., Terre Haute, Ind.
JUTTON, Lee, Gen. Br. Inspr., C. & N. W. Ry., Chicago.
KEEFE, D. A., Cons. Engr., Athens, Pa.
KELLY, C. W., Fairbanks, Morse & Co., Chicago.
KILLAM, A. E., Inspr. B. & B., I. C. R. of Can., Moncton, N. B.
KING, A. H., Supvr. B. & B., O. S. L. R. R., Salt Lake City.
LARGE, H. M., Mast. Carp., G. R. & I. Ry., Ft. Wayne, Ind.

LICHTY, C. A., Genl. Inspr., C. & N. W. Ry., Chicago.
LOFTIN, E. L., Supvr. B. & B., Q. & C. Ry., Vicksburg, Miss.
MARKLEY, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
MARKLEY, J. H., Master B. & B., T. P. & W. Ry., Peoria, Ill.
McKEEL, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McLEAN, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
McNAB, A., Supvr. B. & B., P. M. R. R., Holland, Mich.
MILLS, R. P., Supvr. Bldgs., N. Y. C. & H. R. R. R., New York City.
MOORE, W. H., Engr. Bridges, N. Y. N. H. & H. R. R., New Haven, Conn.
MUSGRAVE, C. T., B. & B. For., O. S. L. R. R., Idaho Falls, Idaho.
MUSSER, D. G., Mast. Carp., Pa. Lines West, Wellsville, O.
NUELLE, J. H., Engr. M. of W., N. Y. O. & W. Ry., Middletown, N. Y.
PARKER, J. F., Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Cal.
PATTERSON, S. F., B. & M. R. R., Concord, N. H.
PENWELL, J. N., Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
PICKERING, B. F., Supvr. B. & B., B. & M. R. R., Salem, Mass.
POTTS, J. O., M. of W. Inspr., B. & O. R. R., Baltimore.
REID, R. H., Supvr. Bridges, L. S. & M. S. Ry., Cleveland, O.
RINEY, M., For. B. & B., C. & N. W. Ry., Baraboo, Wis.
ROBINSON, J. S., Div. Engr., C. & N. W. Ry., Chicago.
SCHALL, F. E., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.
SCHENCK, W. S., Mast. Carp., B. & O. R. R., Connellsville, Pa.
SHELDON, J. B., Supvr. B. & B., N. Y. N. H. & H. R. R., Providence, R. I.
SIBLEY, C. A., Const. Engr., New Haven, Conn.
SMITH, C. E., Bridge Engr., Mo. Pac. System, St. Louis, Mo.
SPENCER, C. H., Engr., Wash. Term. Co., Washington, D. C.
STATEN, J. M., Genl. Inspr. of Bridges, C. & O. Ry., Richmond, Va.
STORCK, E. G., Mast. Carp., P. & R. Ry., Philadelphia, Pa.
STROUSE, W. F., Asst. Engr., B. & O. R. R., Baltimore.
SWARTZ, H. C., Master B. & B., G. T. R., St. Thomas, Ont.
SWEENEY, W. M., For. B. & B., C. & N. W. Ry., Green Bay, Wis.
TANNER, S. C., Mast. Carp., B. & O. R. R., Baltimore.
TAYLOR, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
TAYLOR, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
TAYLOR, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
TEAFORD, J. B., Supvr. B. & B., Southern Ry., Lawrenceburg, Ky.
TEMPLIN, E. E., For. Carp., P. & R. Ry., Pottsville, Pa.
VANDEGRIFT, C. W., Supvr. B. & B., C. & O. Ry., Alderson, W. Va.
WALLENFELSZ, J., Mast. Carp., Pa. Lines West, Cambridge, O.
WARCUP, C. F., For. Water Service, G. T. R., St. Thomas, Ont.
WELKER, G. W., Supvr. B. & B., Southern Ry., Alexandria, Va.
WENNER, E. R., Supvr. B. & B., L. V. R. R., Ashley, Pa.
WOOD, J. P., For. B. & B., P. M. R. R., Edmore, Mich.
WRIGHT, C. W., Mast. Carp., L. I. R. R., Jamaica N. Y.
ZOOK, D. C., Mast. Carp., Pa. Lines West, Ft. Wayne, Ind.

The following applicants for membership subsequently elected were also present:

BLOWERS, S. H., For. Carp., B. & O. R. R., Columbus, O.
BOUTON, W. S., Engr. of Bridges, B. & O. R. R., Baltimore.
BRANTNER, Z. T., Gen. For. M. of W. Shops, B. &. O. R. R., Martinsburg, W. Va.
BRICKER, H. R., Inspr. M. of W., B. & O. R. R., Baltimore.
EDWARDS, W. R., Asst. Engr. Brdgs., B. & O. R. R., Baltimore.
ELDER, W. E., Mast. Carp., C. B. & Q. R. R., Burlington, Ia.
HENDERSON, J., B. & B. For., G. T. R., St. Thomas, Ont.
JAMES, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
KNOWLES, C. R., Gen. For. Waterworks, I. C. R. R., Chicago.
LANE, E. G., Asst. Engr., B. & O. R. R., Baltimore.

LONG, M. A., Architect, B. &. O. R. R., Baltimore.
MACE, B. S., Supt. Insurance, B. & O. R. R., Baltimore.
MOORE, E. G., Carp. For., B. & O. R. R., Grafton, W. Va.
O'CONNOR, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
THOMAS, T. E., Mast. Carp., B. & O. R. R., Wilmington, Del.
WHITNEY, W. C., Supr. B. & B., B. & A. R. R., Boston.

Total number of members registered, 103.

The President:—Next in order is the reading of the minutes of the last meeting, but as they have been published and every member has received a copy of the proceedings in which they are contained I do not deem it necessary to have them read at this time.

The next order of business is the admission of new members. We will now have the report of the membership committee.

REPORT OF COMMITTEE ON MEMBERSHIP.

Salt Lake City, Oct. 10, 1912.

This committee sent out its circulars and application blanks as in previous years where, in its judgment the best results could be obtained, with the object of soliciting only members who would prove creditable to this association, maintain its character for usefulness, and perpetuate its value as an aid to successful modern railway work. We believe that when our members realize that the purpose of this association is to perfect and simplify methods for the better execution of the branch of work assigned to our department the railway companies are being directly benefited, and the reason for our existence is apparent.

Our circulars show the purposes of our association, give the personnel of committees; subjects for discussion at this meeting, and a list of officers and executive members. The secretary of this association has materially assisted in the work of securing new members by sending out to each of the members a copy of the circular and causing to appear in the "Bulletin" an article bearing upon this subject. It will be noticed that the increase in membership is made up largely from the western half of the country although our members cannot be said to be confined to any one section. The increase numerically has been very gratifying as we now have more members than in any previous year of our history as an association.

The following list of applicants is submitted at this meeting for your consideration and their election to membership is recommended by the committee:—

NEW MEMBERS.

Ashton, D. H., Asst. Engr. Const., O. S. L. R. R., Salt Lake City.
Barr, Robt., Foreman B. and B., O. S. L. R. R., Pocatello, Idaho.
Bishop, R. R., For. B. and B., S. P. L. A. & S. L. R. R., Salt Lake City.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bonner, J. K., Asst. Supvr. B. & B., N. Y. C. & H. R. R. R., Rochester, N. Y.

Bouton, W. S., Engr. of Bridges, B. & O. R. R., Baltimore, Md.
Brantner, Z. T., Gen. For. M. of W. Shops, B. & O. R. R., Martinsburg, W. Va.
Brewer, W. A., Asst. Engr., C. & N. W. Ry., Clyman, Wis.
Bricker, H. R., Inspr. M. of W., B. & O. R. R., Baltimore, Md.
Burns, W. E., Asst. Engr., Sou. Pac. Co., Portland, Ore.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
Connolly, C. G., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Crites, G. S., Div. Engr., Sou. Pac. Co., Los Angeles, Cal.
Crosman, D. M., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Degnan. L. V., Chief Draftsman, Sou. Pac. Co., Oakland Pier, Cal.
Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
Eastman, J. S., For. B. and B., O. S. L. R. R., Idaho Falls, Idaho.
Edwards, W. R., Asst. Engr. Bridges, B. & O. R. R., Baltimore, Md.
Elder, W. E., Mast. Carp., C. B. & Q. R. R., Burlington, Iowa.
Gaut, J. B. Br. Inspr., G. T. Ry. Montreal, Que.
Gentis, Ira, B. and B. Foreman, Sou. Pac. Co., Oakland, Cal.
Gordon, Guy, For. Water Service, C. R. I. & P. Ry., Little Rock, Ark.
Gureizky, J., For. B. and B., Col. Mid. Ry., Colorado City, Colo.
Harris, C. J., For. B. and B., O. S. L. R. R., Idaho Falls, Idaho.
Henderson, J., Foreman B. and B., G. T. Ry., St. Thomas, Ont.
Hitesman, U. S., Gen. For., N. Y. C. & H. R. R. R., New York City.
James, A. J., Gen. For. B. & B., A. T. & S. F Ry., Topeka, Kans.
Kibbey, G. S.. Asst. Engr., M. & St. L. R. R., Minneapolis, Minn.
Knowles, C. R., Gen. For. Water Works, I. C. R. R., Chicago.
Lane, E. G., Asst. Engr., B. & O. R. R., Baltimore, Md.
Little, J. W., Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Long, M. A., Archt., B. & O. R. R., Baltimore, Md.
Mace, B. S., Supt. of Insurance. B. & O. R. R., Baltimore, Md.
Mayer, M. J., Ch. Draftsman, Sou. Pac. Co., San Francisco, Cal.
Moore, E. G., For. Carpenter, B. & O. R. R., Grafton, W. Va.
Murphy, J. J., For. Water Service, Sou. Pac. Co.. Oakland, Cal.
Newhall, V. A., Engr., Alberta Interurban Ry., Calgary, Alta.
O'Connor, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
Plank, D. E., Supvr. B. and B., Pac. Elec. Ry., Los Angeles, Cal.
Pollard, Homer, Bridge Inspr., Sou. Pac. Co., West Oakland, Cal.
Redinger, C. A., Asst. Engr. M. of W., Southern Ry., Charlotte, N. C.
Robinson, A. W., Asst. Engr., O. S. L. R. R., Salt Lake City.
Rose, Norman, Supvr. B. and B., Sou. Pac. Co., Portland, Ore.
Rose, W. M., For. Water Service, Sou. Pac. Co., Sacramento, Cal.
Roy, C. M., Gen. Bridge For., L. & N. R. R., Birmingham, Ala.
Searls, Niles, Gen. Fire Inspector, Sou. Pac. Co., San Francisco, Cal.
Stevens, A. R., For. B. and B., O. S. L. R. R., Salt Lake City, Utah.
Stewart, W. G., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Swan, L. W., Supvr. B. and B., L. V. R. R., Easton, Pa.
Thomas, T. E., Mast. Carp., B. & O. R. R., Wilmington, Del.
Wagner, R., Asst. Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
Wells, A. A., R. M. and Supr. B. & B., Sou. Ry., Winston-Salem, N. C.
Wells. D. T., For. B. and B., O. S. L. R. R., Salt Lake City, Utah.
Whitney, W. C., Supvr. B. and B., B. & A. R. R., Boston, Mass.

Total number of new members, 54.

Respectfully submitted,

A. H. King,
Chairman.

The secretary was instructed by a vote of the association to cast one ballot for the election of the applicants named, making them members, whereupon they were declared entitled to all the rights and privileges of the association.

A recess was taken to welcome the new members and distributing the badges.

Next in order was the President's address.

PRESIDENT'S ADDRESS.

Gentlemen and Members of the American Railway Bridge & Building Association: This is the twenty-second annual convention of our organization. About 21 years ago the first meeting was held at St. Louis, where the organization was born. There are many things for which this association should be thankful upon coming of age. From the original 60 charter members the flattering increase to over 500 members at this time is a matter of record; the publications issued by the association are examples of a progressive and working organization, which are not only eagerly looked for by its members, but are highly prized by the railroad world at large. However, more than this, from the very beginning this organization has cultivated and fostered a spirit of fraternity and brotherly love among its members; this spirit, through all the years of the existence of this association, has been husbanded and nourished, until today it forms one of our most cherished assets. It is handed down to us by our fathers, so to speak, and we hope that there will never be any other feeling among us; if any rivalry is to exist, let it be one of interest and zeal as to who can do most for the further upbuilding of the association in assisting the committees, in any manner whatever, to bring out the best reports on the subjects assigned.

The duties of a superintendent of bridges and buildings 21 years ago were probably not as varied and complex as those of today, but the founders of this organization had their knotty problems to solve, as we have today; they felt that through an organization of this kind they could better themselves, could help their brother members, and could serve their employers better. Such is our inheritance, and like good stewards it is our duty to improve our talents.

As mentioned before, we have passed the 500 mark in the numerical strength of the association; the increase of members has been particularly gratifying during the past decade as the following figures will show:

Charter membership at first meeting	in	1891—	60
Membership	"	1896—	140
"	"	1901—	171
"	"	1906—	340
"	"	1911—	499

This healthy increase in the membership, while very gratifying, brings to us increased duties and responsibilities. The railway world at large, as well as our employers, are following our actions. If we are true to our calling and if we respect the high examples set for us by our predecessors in the service of our organization, we must strive to do our utmost to bring out the best that is in us; we need it, our co-laborers need it, our organization needs it to accomplish its purpose; we should improve in our work as we increase in numbers.

We are expected to improve in the manner of preparing our reports; we must make the most of the opportunities offered by acting as chairmen on committees; this is an honor conferred and if con-

sistently and honestly attended to will bring its reward in the experience gained through the investigations and compilations necessary to prepare a report, and also in the incalculable benefits that are bestowed upon those are not so favorably connected as some of us. Also the younger men who must gain experience from their elders need our advice and counsel, that they may be enabled to carry forward the great work that has been assigned to us as individuals and as members of our beloved organization.

Every member is expected to do his part, every one can assist. The chairman must receive information from the members if our reports are to be what they should be. When we receive a communication from one of the chairmen requesting information we should furnish it promptly. If we have no experience in that particular line, we should answer the letter and say so. That is the least that we can do. There is a feeling among some of the members that they are not in a position to help in the reports. This is a mistaken idea. I am satisfied that every member has some good idea, some method or way to do a thing better than his neighbor; this idea is what we want. Every one should take part in discussions on the floor of the convention. This is a good way to bring out ideas; we all learn by discussing subjects and our publications become the more valuable.

To those who have given their leisure hours for the benefit of this organization in acting as chairmen of committees or as committee members, or who have in any manner whatever assisted in making this convention a successful one, as I feel it will be, the thanks and appreciation of your officers are expressed.

To close this address, without at least referring to the ladies who have accompanied their husbands and friends to this convention, would be to shut out the sunshine and brightness; it is another of the precious precedents handed down to us and we must acknowledge that the ladies have done their share in cultivating and maintaining the brotherly love and affection existing among the members of this association; we all appreciate their presence at our conventions.

The most painful duty that has fallen to my lot is the announcement that death has again invaded our ranks, calling to their eternal rest A. Amos, H. W. Phillips, Geo. J. Bishop, W. W. Perry and W. T. Powell. The committee on memoirs will appropriately refer to the memory of these departed members in its report.

In conclusion, I desire to express my hearty thanks to our secretary, the chairman and members of committees, and the membership at large, for their hearty co-operation during the past year in handling matters pertaining to the work of this association. I bespeak for my successor in office the most loyal support, so that this organization may grow both numerically and otherwise; let every member help in the work. Only when this is actually done may we be able to accomplish the high ideals set for us by the organizers of the association and the requirements of our membership.

REPORT OF EXECUTIVE COMMITTEE.

A meeting was held on Oct. 19, 1911, at the close of the St. Louis convention at which Messrs. Rettinghouse, Penwell, Eggleston, Killam, Schall and Lichty were present. The secretary was authorized to turn over to Mr. Jutton, chairman of the committee on "Fireproofing Timber Trestles," the funds necessary to carry on a number of tests for fire-resisting paints, said sum not to exceed $100.

The secretary was authorized to have 700 cloth bound volumes and 500 paper bound volumes of the 1911 proceedings printed.

At a meeting held in Chicago, March 20, 1912, Messrs. Schall, Penwell, Hadwen, Fullem, Swenson, Eggleston, Aldrich and Lichty were present. Mr.

G. W. Andrews, chairman of the committee on arrangements, reported with reference to the hotel conditions at Baltimore. It was finally decided to hold the twenty-second annual convention at the Emerson hotel, and Mr. Andrews was instructed to make the necessary arrangements.

A meeting of the committee was held at the Emerson hotel, Monday evening, Oct. 14, 1912, at which Messrs Schall, Penwell, Aldrich, Killam, W. O. Eggleston and Lichty were present. Matters were discussed relative to some of the committee reports and to the editing of the proceedings. It was resolved that the association use its influence in urging chairmen of committees to complete their reports in time to enable the secretary to mail out advance copies several weeks prior to the convention.

A meeting was held at the close of the Baltimore convention with Messrs. Killam, Penwell, Aldrich, Jutton, Tanner, Smith and Lichty in attendance.

The secretary was instructed to have 800 copies of the proceedings bound in cloth and 400 copies in paper covers. It was suggested by Mr. Smith that hereafter the membership cards should be made to answer as receipts for dues by making some slight changes in the printing of the cards.

C. A. LICHTY,
Secretary.

REPORT OF THE SECRETARY.

Baltimore, Oct. 15, 1912.

To the Officers and Members of the American Railway Bridge and Building Association:

Twelve hundred copies of the 1911 proceedings were issued, 700 with cloth covers and 500 with paper covers. Four numbers of the Bulletin were issued during the year. We now have a membership of about 530. The financial statement is as follows:

FINANCIAL.

RECEIPTS.

Balance on hand, last report,	$ 683.39	
Fees and dues,	859.00	
Advertisements,	1,210.40	
Sale of books,	16.75	
Badges,	7.75	$2,777.29

EXPENDITURES.

Stationery and office supplies,	$ 11.90	
Postage,	145.60	
Printing and engraving,	888.78	
Drafting,	53.65	
Editing,	75.00	
Badges,	128.00	
Treasurer's Bond,	7.50	
Stenographer,	138.10	
Committee expenses,	98.78	
Salaries,	600.00	
Expenses Secretary Emeritus,	40.55	
Annual meeting expenses,	91.15	
Telegrams, express and exchange,	9.19	
Miscellaneous,	6.25	$2,294.45
Balance on hand,		$ 482.84

Respectfully submitted,
C. A. LICHTY,
Secretary.

REPORT OF THE TREASURER.

To the Officers and Members of the American Railway Bridge and Building Association:

Your treasurer presents the following report for the year ending Oct. 15, 1912:

Balance on hand Oct. 19, 1911,	$1,311.10
Interest,	49.86
Balance on hand, Oct. 15, 1912,	$1,350.96

Respectfully submitted,

J. P. Canty,
Treasurer.

REPORT OF RELIEF COMMITTEE.

Joliet, Ill., Oct. 12, 1912.

To the Officers and Members of the American Railway Bridge and Building Association:

The committee on relief is pleased to report that during the past year but one application has been received for assistance in securing a position. About 50 circular letters were prepared and sent to members of the association. The applicant now has a temporary position and we anticipate that a permanent position will be secured in a short time.

In connection with the work of this committee, it is suggested that any member of the association who knows of an opening should advise the chairman in order that applicants for positions hereafter may be promptly notified.

Respectfully submitted,

Arthur Montzheimer,
Committee.

The President:—The secretary will read a letter of interest to the association. The secretary read the following letter from Mr. John Foreman, one of our life members:

Pottstown, Pa., October 2, 1912.

Mr. F. E. Schall, President American Railway Bridge and Building Association, So. Bethlehem, Pa.

My dear Mr. Schall:

I am in receipt of your kind letter of the 28th ult., extending to me a special invitation to attend the annual convention of the American Railway Bridge and Building Association, which will be held in Baltimore October 15th, 16th and 17th, and in reply, I am obliged to express my regrets as I find that my health which is somewhat impaired at this time, will not permit of my making the trip.

On the 25th of July last, I celebrated the 89th anniversary of my birth and from this you will note that I am of necessity not as active as I was when I used to attend our annual gatherings. I have always enjoyed meeting with the members of the association and I can truthfully say that such meetings gave me more pleasure than any other meetings I ever attended. I have al-

ways found the members congenial and ever ready to make it pleasant for each other and I certainly regret that I am unable to be with them at the meeting to be held this month, notwithstanding it is not very far from my home

I wish you would convey to the members my very best wishes for a pleasant time, and trust the meeting will prove beneficial to each one who is fortunate enough to be there. Tell them that while I am unable to be at the meeting, I shall think of them while they are attending the convention. If you should happen to visit Pottstown I would be pleased to have you call to see me.

Thanking you for the special invitation sent me and with kindest regards, believe me to be,

Sincerely yours,
JOHN FOREMAN.

The president announced that he was prompted by Mr. W. M. Camp to invite Mr. Foreman to attend the meeting and this letter was the result.

It was moved by Mr. Killam that the association acknowledge receipt of Mr. Foreman's letter and that we send him our most hearty greetings. The motion was carried.

The President:—I will appoint the following committees: to audit the accounts of the secretary and treasurer, W. O. Eggleston, R. H. Reid and F. A. Taylor; on selection of subjects, C. E. Smith, A. S. Markley, G. Aldrich, D. C. Zook and R. H. Reid; resolutions, Lee Jutton, R. H. Reid and G. Aldrich.

Mr. Lee Jutton was appointed assistant secretary.

REPORT OF THE AUDITING COMMITTEE.

To the Officers and Members of the American Railway Bridge and Building Association:

The auditing committee has carefully examined the books and accounts of the secretary and the treasurer and finds that the reports, as presented, are correct.

Respectfully submitted,

W. O. EGGLESTON,
R. H. REID,
F. A. TAYLOR,
Committee.

The report of the committee was accepted and ordered placed on file and the committee discharged.

The president announced that the next order of business would be the taking up of the regular subjects for report and discussion. Mr. Lee Jutton, chairman of committee No. 1, was called upon to read his report and to open the discussion. (See report of committee and discussion.)

The president called upon Mr. J. N. Penwell, chairman of committee No. 2, " Derricks and Other Appliances for Handling Material in Supply Yards," to read the report and open the discussion.

At the noon hour adjournment was taken until 1:30 P. M.

AFTERNOON SESSION.

Tuesday, Oct. 15, 1912.

The discussion of Subject No. 2, which had been taken up during the forenoon was resumed and completed. (See report and discussion.)

Subject No. 3 went by default as the committee failed to submit a report.

Subject No. 4, Concrete Tanks, Stand Pipes and Reservoirs, did not appear in pamphlet form. The report was read by Mr. Jutton, assistant secretary, in the absence of the chairman. (See report and discussion.)

Subject No. 5, Best and Most Economical Pumping Engines. was not reported upon.

The chairman of the committee on Subject No. 6, Roofs and Roof Coverings, presented a letter as follows:

Chicago, Oct. 12, 1912.

Gentlemen:

As chairman of committee on Roofs and Roof Coverings I beg to report that there has not been a meeting of the committee this year, and nothing has been accomplished through the medium of correspondence which warrants any modification or change in the report on this subject submitted last year.

Some members at the convention will probably have recommendations to make, but for my part I can say that my experience since the last convention with different types of roofings has still further convinced me that the report submitted last year, particularly regarding the value of the built-up type of roofing as compared with the various prepared roofings should be allowed to stand.

T. J. Fullem, *Chairman.*

(The subject was not discussed.)

The discussion of Subject No. 7, Reinforced Concrete Culvert Pipe, was opened by Mr. H. H. Decker in the absence of Mr. Hadwen, the chairman. (See report and discussion.)

After discussion of Subject No. 7 adjournment was taken until Wednesday morning.

MORNING SESSION.

Wednesday, Oct. 16, 1912.

President Schall called the convention to order at 9:30 A. M.

Subject No. 8, The Construction and Maintenance of Long Pipe Lines for Locomotive Water Supply, Intakes, Pump Pits, Reservoirs, etc., was read by the secretary in the absence of Mr. B. J. Mustain, the chairman. The discussion of the report followed. (See report and discussion.)

At the conclusion of Subject No. 8 the president read the report of the nominating committee:

REPORT OF THE NOMINATING COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

The committee on nominations begs leave to submit the following list of names for officers of this association for the ensuing year:

President, A. E. Killam, I. C. R. of Canada.
First Vice-President, J. N. Penwell, L. E. & W. R. R.
Second Vice-President, L. D. Hadwen, C. M. & St. P. Ry.
Third Vice-President, T. J. Fullem, I. C. R. R.
Fourth Vice-President, G. Aldrich, N. Y. N. H. & H. R. R.
For members of Executive Committee: G. W. Rear, W. F. Steffens, E. B. Ashby, C. E. Smith, S. C. Tanner, Lee Jutton.

R. H. Reid,
S. F. Patterson,
J. H. Markley,
J. F. Parker,
Committee.

It was announced by the president that according to the constitution the report must lie over until the third day of the convention.

Subject No. 9, Turntables, was next taken up for discussion, which was opened by Mr. C. E. Smith, the chairman. (See report and discussion.)

At 12 o'clock adjournment was taken until afternoon.

AFTERNOON SESSION.

Wednesday, Oct. 16, 1912.

Meeting called to order by the president at 2 P. M.

A telegram was read from Mr. W. A. McGonagle wherein he stated that he was sorry that he could not be in attendance at the convention.

The discussion of turntables was resumed and continued at considerable length until the president ruled that the discussion be closed and that any member having anything further to add should submit it in writing to the secretary.

Subject No. 10, Track Scales,—Construction and Maintenance, was next in order. Upon a suggestion from the American Railway Association it was recommended that a few items be withheld from the report. The report was quite comprehensive but incomplete; it was passed without discussion and recommended to be carried over until next year. A motion to that effect was made and was carried.

The next report in order was No. 11, Painting of Structural Iron or Steel, fór Both Bridges and Buildings. The report was read and the discussion opened by the chairman, Mr. Ettinger. At the close of the discussion it was voted to allow Mr. Coleman, a member of the American Society for Testing Materials, of Cleveland, the floor for a few minutes to address the convention on the Theory of Corrosion on Iron and Steel.

The remainder of the afternoon was occupied in the discussion of Subject No. 11, Relative Merits of Brick and Concrete in Railway Buildings and Platforms. In the absence of the chairman, Mr. Hand, the secretary presented the paper and read extracts therefrom.

Adjournment was taken at 5:30 until Thursday morning.

MORNING SESSION.

Thursday, Oct. 17, 1912.

Meeting called to order at 9:30 A. M. by the president.

The report of the obituary committee was presented by the chairman, Mr. J. N. Penwell.

REPORT OF THE OBITUARY COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

Whereas, our Heavenly Father in his divine wisdom has called from our midst, and from this busy life five of our beloved members and friends, thus reminding us of the certainty of death, and the importance of right living, therefore be it

Resolved, That although death is the natural end of man, and all things else, we deeply and sincerely mourn the loss of these faithful members: A. Amos, W. H. Phillips, George J. Bishop, W. W. Perry and W. T. Powell,

Resolved, That the secretary extend to the widows and families of these deceased members the sincere sympathy of our association, and that a copy

of these resolutions be sent to their respective families, and spread upon the minutes and printed in our proceedings.

J. N. Penwell,
Committee.

REPORT OF THE PUBLICATION COMMITTEE.

To the American Railway Bridge and Building Association:

The committee on publications met several times to assist the secretary in outlining and preparing the work for the proceedings.

We desire to call the attention of our members to the urgent necessity of getting the reports out on time, in order that the association may have the benefit of the printed reports at least several weeks before the annual meeting. This will permit the members to prepare oral discussions or to send in written discussions if they find they will be unable to attend.

We also mention the fact that several new members acted as chairmen of committees during the past year and each filled the position with credit to himself and the association.

We trust that the work of the coming year will be taken up promptly and that the secretary will be given encouragement in getting the work out early.

R. C. Sattley,
A. Montzheimer,
Lee Jutton,
Committee.

The President:—We will next proceed to the election of officers. I will appoint Messrs. Knowles, Pickering and Clark as tellers.

Mr. Pickering:—We have been working rather hard and I know there is no contest here, hence I move that the assistant secretary cast one ballot for the list of officers as presented by the nominating committee.

The motion was seconded and carried unanimously and the assistant secretary cast the ballot.

President Schall:—The time has arrived to install the new officers, but before we begin that, I want to express my appreciation to you for the careful attention and the active work of the year just passed. I hope that you will accord to my successor the same co-operation. Give him all the assistance you can. Work out your reports early, so there will be no anxiety on his part in getting the work moving as it should. Mr. A. E. Killam, you have been elected as president of this association for the ensuing year. Are you willing to accept the office?

Mr. Killam:—I am.

President Schall:—Please step forward. With this gavel, I transfer to you the authority of this office. (Applause.)

President Killam:—Mr. Secretary and fellow laborers in the

Bridge and Building Association of this broad country of ours, and when I say this broad country of ours, I don't refer to any lines, but to the extent of this country from the Gulf of Mexico to the North Pole: This coming year, we have a large field before us and a large amount of work to do. I want to refer to the excellent work done by the committees for the past year. The reports of this year have certainly surpassed anything that we have had heretofore and I trust that the committees we have appointed for the coming year will equal, and if possible will excel, those heretofore.

This association of ours has been very dear to me. I have been now meeting with you for 15 years, and they have been 15 years of pleasure. I have looked forward every year to the time when I should meet the noble faces I see before me at this time in conference for the country's good, because I claim that there is no class of men that have the interests of the great traveling public so much at heart as the men who look after the buildings and the bridges in particular. One can get by a poor building, but he cannot get by a poor bridge. They have to be looked after, and if they are looked after as these men of the association, our brothers in the service, look after them, there will be no danger. It is a work in which I take delight. I have been in bridge work for about 40 years, and I am not tired of it yet.

I will close my remarks by saying that we will undertake to do the very best we can for the public at large and for those who employ us and pay our expenses and wages. Therefore, gentlemen, we will proceed to the closing of this session and we will go home with fond remembrances of the treatment we received from the city of Baltimore.

The other officers were then installed.

The Secretary:—I desire to say that Mr. Killam has earned the promotion which has come to him. He joined the association at Richmond in 1898, which meeting he attended and has not missed a convention since. In all these years he has been active in the work of the association and always performed every duty that was assigned to him. Hence I say that he richly deserves the honor that has been conferred upon him here today, and the association has honored itself in naming him for its next president.

The first meeting which I attended was at Detroit in 1899, and I well remember the active interest that was exercised by

many of our older members, a goodly number of whom are in attendance at this meeting, among them our honored president of that year. I have been in attendance every year since. Our older members are gradually falling off or retiring and the work of conducting the affairs of this association devolves upon those of us who are still active. Much depends upon the newer members and they should make it a point to get interested in the active work as early as possible in order that they may get the benefit of the experience which will come to them in research, as well as the association receiving the benefits of their experiences. There is a vast amount of work to do if we are to make a success of the problems which present themselves for the coming year. If we all assist in the work—no matter how little—it will help.

Your secretary takes much interest in the work which is consigned to him, for if he did not he could not successfully carry it on in connection with his regular vocation. I wish to thank you for the confidence you have reposed in me in electing me to serve another year in this important position and it is my earnest desire that you may not be disappointed in my efforts.

The Secretary:—I find that Mr. Wm. Carmichael, one of our earliest members, who up to a few years ago had always been prompt in payment of dues, had the misfortune several years since to lose a leg and since that time he has fallen behind. Mr. Carmichael is employed by the St. Joseph & Grand Island R. R., at St. Joseph, Mo., in the same office with Mr. O. H. Andrews. I think the association would be justified in remitting his dues and in making him a life member.

Mr. Pickering:—I think that we are but honoring ourselves if we confer that title upon our faithful old members who have become incapacitated. I offer a motion that Mr. Carmichael's dues be remitted and that he be elected a life member. I would like to include in the motion the name of Mr. W. A. Lydston, my predecessor in office. He has been retired from duty on the B. & M. R. R.

The motion was duly seconded and carried.

Mr. G. W. Andrews:—I would like to offer the name of Neil McLean, of the Erie railroad. This is without any solicitation on his part as far as I know. Mr. McLean is now past his seventy-third year, and we all know what that means in railroading. It is only a matter of a very short time until Mr. McLean will have to retire. We hope of course that he will not, but taking the

ordinary and general run of events in railroading, a man who reaches 73 in the service is very remarkable. I offer a motion that Mr. Neil McLean be made a life member of this association. (The motion was seconded and carried.)

Mr. J. H. Markley:—I would like to present the name of Mr. W. M. Noon, one of our retired members, for life membership.

The name of Mr. A. Findley was also presented. Mr. Noon and Mr. Findley were elected life members.

Upon a motion made by Mr. Dupree it was voted that the association provide identification numbers for the ladies who attend future conventions, the numbers to correspond to those worn by their husbands. The secretary was authorized to provide the buttons.

Mr. Dupree brought up the question of changing the time of the annual meeting to the spring of the year, mentioning the fact that it was difficult for many of the members to get away in October when everyone connected with railway work was busy preparing for the winter.

Mr. Pickering called attention to the fact that the constitution states that the convention shall meet each year on the third Tuesday in October, and to bring this matter before the convention in proper form it would be necessary to present the proposition in writing and to give notice to all members at least 60 days prior to the meeting.

The president announced that the next order of business would be the selection of the place to hold the next convention.

Mr. Pickering called to the attention of the older members the fact that nine years ago it was decided that a few members should give Quebec a complimentary vote to show our appreciation, at least to some extent, of the efforts of our friend Killam, who for years pleaded urgently that we "come over" and enjoy genuine Canadian hospitality. The joke turned out to be a reality and the vote was decided in favor of Quebec. Mr. Pickering alluded to the earnest efforts put forth by Mr. Killam that year and described the care with which he arranged every detail which made for the success of that convention and the entertainment of those present,—the most successful of any held up to that time. He spoke of the loyalty of Mr. Killam to this association. He mentioned the fact that Mr. Killam had been in attendance at every convention since he joined, at Rich-

mond, in 1898, and that he had been honored by being chosen president because he deserved it in every respect.

Mr. Pickering then made a motion that we honor Mr. Killam by holding the next convention in Montreal, stating that he was not superstitious at the time when we decided to go to Quebec for the holding of our 13th annual meeting (the year that he himself was president) and he predicted nothing but a successful meeting if we decided to hold the 23rd convention in Montreal in 1913.

The motion was seconded and carried, whereby Montreal received the unanimous vote by acclamation without having a rival, which was perhaps the only instance of like character in the history of the organization.

Mr. Aldrich reported that he had recently met Mr. Cyrus P. Austin, one of our life members, who served several years as treasurer and who wished to be remembered to all of our members in attendance at this convention.

Upon a motion made by Mr. R. H. Reid the secretary was instructed to send to Mr. Austin a letter of greetings conveying the best wishes of those present.

The committee which was appointed to select subjects for report and discussion for next year presented the following:

REPORT OF COMMITTEE ON SUBJECTS.

To the Members of the American Railway Bridge and Building Association:

We submit the following list of questions for report and discussion at our next annual meeting:

1. Water Supply.
2. *Track Scales.
3. Equipment and Tools for Bridge Gangs.
4. Concrete Culverts and Various Kinds of Pipe for Culverts.
5. Heating, Lighting and Ventilating of Round Houses and Shops.
6. Sewers and Drains.
7. Motor Cars for Bridge Gangs.
8. Temporary Structures for Supporting Tracks during construction of Permanent Work, Sewers, etc.
9. Concrete Posts, Poles, Signs, etc.
10. Snow Fences.
11. Preservation of Timber.
12. Cattle Guards.
13. Fire Resisting Coatings for Timber.

(*Carried over from last year.)

C. E. Smith,
A. S. Markley,
G. Aldrich,
D. C. Zook,
R. H. Reid,
Committee.

The president announced that if no further business appeared we would receive the report of the committee on resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS.

To the Members of the American Railway Bridge and Building Association:

The committee on resolutions respectfully submits the following report:

Resolved, that the thanks of the association be extended to Mr. Robert E. Lee, for his address to the members and their friends, and the hearty welcome from the mayor and citizens to our members and others in attendance at our convention;

To the management of the Emerson hotel, for the courteous treatment of the members and their families;

To the representatives of the various railway engineering magazines who reported our proceedings for their several journals;

To the Pullman Company and the various railroads, for courtesies shown our members and their families en route to and from the convention;

To the people of Baltimore, who, through Mr. Anderson Polk furnished entertainment for the ladies at the Country Club;

To the Railway Bridge and Building Supply Men's Association for valuable services rendered in entertaining our members and their friends;

To the Baltimore & Ohio Railroad for furnishing a special train and luncheon to our members and escorting them about the Baltimore terminals;

To the officers and committees, who rendered valuable time and assistance in promoting the welfare of the association during the past year.

R. H. Reid,
G. Aldrich,
Lee Jutton,
Committee.

No further business appearing the meeting adjourned to meet in Montreal the third Tuesday in October, 1913.

G. K. ANDERSON,
Stenographer.

C. A. LICHTY,
Secretary.

MEMOIR.

Alexander Amos died at his residence, 1023 28th Ave., N. E., Minneapolis, March 17, 1912, at the age of 71 years, 8 months and 16 days.

He entered the army in the 142nd regiment of New York and served two years and nine months, being discharged as first lieutenant, on Feb. 17, 1865. He then located at Norwood, N. Y., as a mechanic. In 1879 he went to Minnesota and entered the service of the Chicago, Milwaukee & St. Paul Ry., as general foreman of bridges and buildings of the Southern Minnesota Division.

ALEXANDER AMOS.

He became superintendent of bridges and buildings of the Minneapolis, St. Paul & Sault Sainte Marie R. R., in 1886, which position he held until two years ago when he was pensioned on account of having reached the age limit.

Mr. Amos is survived by a wife and three sons, Oscar, William and Merton. He expired suddenly while retiring for the evening.

Funeral services were held at Minneapolis March 18, and the body was sent to Norwood, N. Y., where Mr. Amos was born, for interment.

Mr. Amos joined the association in 1902 and was elected a life member in 1910.

MEMOIR.

George J. Bishop was born Dec. 4, 1851, at White Haven, Pa. He left school at the age of 14 to work in the pine forests and saw mills of the upper Lehigh region of Pennsylvania. He worked in the bridge and building department of the Lehigh Valley R. R. as a carpenter from 1869 to 1871. Following this he worked for several years as a carpenter and as carpenter foreman for various contractors on buildings and coal breakers in the anthracite coal regions of Pennsylvania.

GEORGE J. BISHOP.

In the year 1877 he went west and began as a building carpenter foreman on the Hannibal & St. Joseph R. R. where he remained until 1879, when he entered the service of the Denver & Rio Grande as foreman, soon being promoted to the position of superintendent of bridges and buildings. He held this position until 1883 when he went with the Union Pacific R. R. as foreman and general foreman of bridges and buildings, remaining with this road until April, 1887. From this time until 1903 he was engaged with the C. K. & N., now a part of the Rock Island System. He was then made master of bridges and buildings of the Grand Trunk at Durand, Mich., remaining here until 1906.

Upon leaving the Grand Trunk Mr. Bishop followed contract work for about a year and then entered the service of the San Antonio & Aransas Pass Ry., at Yoakum, Texas, as timber inspector, which position he held at the time of his death which occurred July 17, 1912, at Bayou Sale. La., from acute indigestion. His body was taken to Wilkes Barre, Pa., where it was interred in the family plot in the Hollenback cemetery.

Mr. Bishop was an active member of this association having joined at Philadelphia in the year 1893.

MEMOIR.

Henry W. Phillips was born at Fall River, Mass., March 13, 1840. His death occurred May 9, 1912, at Harwich, Mass., resulting from a stroke of apoplexy. He began railroad work in 1866 as bridge carpenter on the Old Colony railroad, which later became a part of the New York, New Haven & Hartford railroad. In 1880 he was appointed to the position of foreman of bridges and buildings on the Cape Cod division with headquarters at Hyannis, Mass., and was again in 1880 promoted to the position of supervisor of

W. L. PHILLIPS.

bridges on the Cape Cod and Plymouth divisions, in which capacity he served until he was retired on a pension in April, 1908.

Mr. Phillips was a man of noble character and was highly respected by all with whom he came in contact. The vast throng of railroad men which was assembled at his funeral service gave silent evidence of the esteem in which he was held by those with whom he was associated for so many years.

He is survived by a wife and one son, Henry A. Phillips, who holds the position of district foreman of bridges and buildings at Buzzard's Bay, Mass.

Mr. Phillips became a member of this association in 1903 and was elected to life membership at the annual convention at Washington, D. C., in 1908.

MEMOIR.

William T. Powell was born at Hancock's Bridge, N. J., Nov. 25, 1857, and died at his home in Denver, Colorado, September 30, 1912, after an illness of several months.

When Mr. Powell was 12 years old he left New Jersey and went west with his parents. He worked with his father and brothers on their farm in Iowa until 1882, when he went to Colorado and prospected for two years in the Rocky Mountains. He made his home in Colorado from this time until his death.

Mr. Powell began his railroad career in 1884 with the Union Pacific R. R., as bridge carpenter, being later promoted to foreman on the Denver, South

W. T. POWELL.

Park & Pacific branch of that road. In 1885 he left the Union Pacific and accepted a position as foreman on the Denver, Leadville & Gunnison, working for that company until it went out of existence in 1889, at which time he entered the employment of the Colorado & Southern as bridge carpenter and held that position until he was promoted to foreman. After a few years of faithful service as foreman he was appointed inspector on the same road. In 1902 he was promoted to the position of general foreman. When Mr. O. J. Travis (the founder of this association) retired from the office of superintendent of bridges and buildings, in 1906, Mr. Powell was appointed to fill the office, which position he held at the time of his death.

Mr. Powell was married July 24, 1890, to Miss Bee Smith and is survived by his wife and two daughters, Lillian and Martha.

Mr. Powell became a member of the association in 1901 and attended several of the recent conventions. He had a strong personality, was honored in his private life and was trusted and respected by all his employes, in fact, by all who knew him. The beautiful floral offerings and the large attendance at the last sad rites told how much he will be missed by all his friends, but most of all by his family.

MEMOIR.

W. W. Perry was born Feb. 20, 1837, in Montour Co., Pa., and died at Williamsport, Pa., Aug. 16, 1912. Death was due to acute indigestion from which he had been suffering for some ten days during all of which time he was in an extremely critical condition.

Mr. Perry entered railroad service as a chainman with the engineer corps of the Catawissa, Williamsport & Erie Railroad in Oct., 1853, and served until the completion of the road in July, 1854. He was re-employed as foreman carpenter with the same company, Aug. 1, 1864, promoted to

WILLIAM W. PERRY.

master carpenter, Jan. 1, 1867, and master carpenter of the Shamokin division, May 1, 1889. During his service as master carpenter on the C. & W. branch he also held the position of roadmaster and division engineer in charge of roadway and track. It may be said of him that during a portion of this time he was the defacto superintendent.

During his long career of more than 48 years of railroad service, he made a multitude of friends, both among officials and subordinates, because his sterling uprightness of character and superior ability in his profession commanded the respect and admiration of all.

He was a veritable giant in emergencies, a fact that was amply proven by his brilliant work during the floods of 1889 and 1890 when the Muncy and Sunbury bridges were swept away. He not only executed work of the first order in his department of bridges and buildings, but was a designer of some note as well.

Mr. Perry was retired on a pension Dec. 31, 1911. He was a member of the Masonic fraternity and of the Pine Street M. E. church, at Williamsport,

of which congregation he was one of the stewards. He is survived by his wife and two daughters, one of whom, Miss Sara Perry, resides at home, the other one being Mrs. Lewis Baker, of Tamaqua; also by three brothers, Thomas and Joseph, living at Mooresburg, Pa., and Robert W. Perry, a lumberman in Mississippi, and a sister, Mrs. Mary Budeman, residing in Delavan, Ill.

Deceased joined the association in 1904 and was elected a life member at St. Louis in 1911. He was a regular attendant at the conventions in which he took an active interest. His wise counsel will be missed in future meetings.

Subject No. 1.

FIRE RESISTING COATINGS FOR TIMBER.

REPORT OF COMMITTEE.

The work of this committee for the past year is a continuation of the study outlined in the report submitted to the St. Louis convention last year, Fireproofing for Timber Trestles, and, as instructed by the association, consists of tests of different kinds of fire resisting paints when applied to timber bridges. During the early part of the past summer it was found that this work could not be completed in time to make a final report to this convention. It was therefore decided, with the consent of the president, to get as much as possible done and to make a progress report at this time and a final report to the 1913 convention.

Up to this time we have erected ten test structures, each eight ft. long and about four ft. high, at West Chicago, on the Chicago & Northwestern Ry. The timber for these tests was donated by the Chicago & Northwestern Ry. No paint has been applied to these structures as yet, but this will be done the latter part of this month. They will then stand through the winter and the fire tests will be made in May of June, 1913.

Inquiries have been made of 88 concerns manufacturing paints, each of which was asked if it made a fire resisting paint, and if so if it desired to have its paint tested and a report made to our association as to its merits. As a result of this inquiry 18 concerns sent samples for the test.

No doubt many of our members have done considerable painting of pile bridges and we would like to hear from them with reference to the manner of applying the paint to the different parts, especially as to getting the paint between the stringers, where the space between them is only about four inches.

Lee Jutton,
W. H. Moore,
Committee.

DISCUSSION.

Mr. Jutton:—In the discussion of this progress report I would like to get some idea of the method of procedure in applying the fire test. Of course, we want to approach as nearly as possible the conditions which we have to contend with in actual service, but at the same time we want to have more severe tests than that. I have not decided yet just how we will go about it and I think that this will be a good subject for discussion.

The President:—We will be glad to have this subject discussed by all the members, to bring out the best method for applying this paint and conducting the tests. We will be glad to hear from any of the members.

Mr. A. S. Markley:—I presume it is the intention to have a separate structure for each kind of paint?

Mr. Jutton:—As I said, we have about 18 samples of paint and only 10 dummy structures erected. I hardly think it will be necessary to erect a separate structure for each paint. I think we can apply at least two paints to one structure, one kind of paint at one end and another at the other end, so that they will meet half-way on the stringers and ties. When we set them afire if one is weak and the other strong, that part covered with the better paint will possibly be saved. If anyone sees any objection to applying the paint in this way, we would be glad to hear it.

Mr. A. S. Markley:—I believe there should be a structure for each kind of paint. Each man who owns or controls a paint should be allowed to paint the structure, and, if it burns, it is up to him. He can apply the paint just as he desires.

Mr. Jutton:—It would be rather difficult to get a workman there from each concern, but I am impressing upon the manufacturers that they should give us all the specifications they have.

Mr. A. S. Markley:—They could employ a man to put the paint on and let us keep clear of it. We are the disinterested ones; let the interested ones apply the paint.

The Secretary:—This association is having these tests made and the different kinds of paint should all be applied by the same workmen just as would be done in actual practice. If a manufacturer sent a representative there, he might alter the paint or the process in a way that we might not do if we applied it ourselves. If they give us the paint and we apply it according to their instructions or directions, it will coincide with what we will have to do in practice. We have the men there to do the work and I think it would be far more satisfactory to proceed in that manner. Some of those firms are located a thousand miles away, and they might not want to send a representative to apply the paint to these small structures; I do not think we should allow them to do it, as it would not be fair to the association when it is making these tests.

Mr. A. S. Markley:—If the manufacturers want to apply the paint and desire to alter it to keep it from burning, let them

alter it. We don't care if they do change it. If it won't burn, it's the material we want. As far as their being a thousand miles away, give them the name of a painter and let them employ him to apply the paint.

Mr. Ettinger:—I have had quite a bit of experience with tests of this nature and I have found that if tests are to be satisfactory to us and to the manufacturers the paints should be used under the same conditions that we use them every day. If we do not do that, we create a special condition. We are not working under special conditions, but under average conditions, and we ought to apply the paint in the same way. If the manufacturer wishes to, let him send a representative. Notify him that we are going to be ready at a certain time and if he wants to see that he gets fair treatment let him be there.

Mr. Penwell:—I have been wondering if it is really a fair test to ask the manufacturer to send us the paint. I think we should buy the paint on the market and apply it ourselves without the knowledge of the manufacturer. Without accusing any manufacturer of unfairness, it would be unfair to allow them to send us the samples, make our tests from the samples and then go into the market and buy the paint for use. We have no absolute guarantee that we are getting paint similar to the sample furnished us. A safer and more practical test would be to buy a gallon or two gallons of paint in the market and then apply it without asking the manufacturer anything about it. Then we would have just such paint, applied in just such a manner as we would apply it if we were using it for fire protection.

Mr. C. E. Smith:—I do not think there is any objection to getting the paint direct from the manufacturer, but I think it should be applied by the bridge men as Mr. Jutton proposes, because it will then be applied in a manner similar to the conditions under which it will be applied in practice.

Mr. Penwell:—It would be all right where we have the formula given so that we can have the paint analyzed and find out if we are getting what we specified; but in this case, we have no formula, as I understand it.

Mr. Jutton:—Even though we buy the paint on the market, we have no guarantee that that paint—say we did find one that we considered first class—would be kept up to that standard. We have received samples within a month or so after I wrote to the manufacturers, and I don't believe that they had time

to get up a special production for our tests. If they did, and did send us something which is the best they have and which is found to be a good paint, we have reason to believe that that is what we would get from them on orders. No matter how we get it, whether we buy it or ask for it, there is no reason to believe that the manufacturers may keep it up to that standard. They may do it and they may not.

Mr. Penwell:—If we buy the paint on the market and decide that a certain paint is the best and is the paint we ought to use, our chief chemist can analyze it and then we can determine by analysis whether it is the same paint we are getting in the future.

Mr. Ettinger:—This is not a paint problem in the common sense of the word and should not be so classed, but it is a fireproofing study and some firms are making a specialty of that, perhaps making no other kind of paint. The formulas are something they possess and never will give up to us unless our chemists can find them, and I am of the opinion that no chemist can find the correct formula for them. If they sell this paint to us, their reputation is at stake.

Mr. Sheldon:—It seems to me that for a comparative test of the qualities of fire-resisting paint, some sections or parts should be left unprotected or untreated in any way, and the same test applied to those parts to get a comparative test between untreated timber and treated timber. If we do that, we will know whether any of the fireproof paints are good or not. In that way we can get at the fire-resisting qualities of most of the paints.

Mr. Jutton:—How would it be to leave a little section untreated?

Mr. Sheldon:—That would be my idea exactly, to leave part untreated and note the result.

Mr. A. S. Markley:—Which would you start the fire on first?

Mr. Sheldon:—All at the same time.

Mr. Ettinger:—We have made a test of that kind. I am afraid the untreated structure will catch fire and you will have trouble on your hands.

Mr. Penwell:—As I remarked in the St. Louis convention, along with the other samples that we propose to use, I hope we will try whitewash at the same time and see whether we want to buy any paint or not.

Mr. Pickering:—It seems to me that the idea advanced by quite a number has been the fair one, that our committee should

be authorized to go into the open market and purchase samples of each of these different makes of fireproofing paint and to apply them under conditions similar to those existing when we purchase the paint to apply it on our bridges. That gives each manufacturer an equal chance and gives us a guarantee that we are getting the market article and not some special paint that the manufacturer has provided to test. Therefore, if it be in order, I would move you that our committee be authorized to purchase a sufficient quantity of the various makes of fire-resisting paints and to apply them to these structures.

Mr. Penwell:—I second the motion.

(The chairman then stated the motion.)

Mr. Knowles:—Is this paint to be purchased in the open market? As I understand, a great deal of it can only be purchased from the manufacturers.

The President:—From the manufacturers or in the open market, as I understand the motion.

(Motion carried.)

Mr. A. S. Markley:—I wish to settle the question as to whether we are to have one structure for each kind of paint, or have two kinds of paint on the same structure. If we have two kinds on the same structure and one starts to burn and heats the other up, the latter is going to catch fire quicker than it otherwise would.

Mr. Jutton:—If it is fire-resisting, it ought not to burn.

Mr. A. S. Markley:—You cannot expect to get paint that will not burn at all. It is the paint that resists the longest that we want to recommend.

Mr. Pickering:—I would like to ask the committee how many different brands of paint they propose to test?

Mr. Jutton:—We already have on hand 18 kinds and we have ten test structures. If we are to apply one type of paint to each structure, we will have to put up a few more. We can do that all right.

Mr. Pickering:—Do you use second-hand timber?

Mr. Jutton:—Yes.

Mr. A. S. Markley:—How are you going to ignite the trestle in these tests?

The President:—That was a particular point the chairman wanted to bring out.

Mr. Killam:—I doubt whether anyone has ever seen a new

structure take fire from coals dropped from a locomotive, but it is always a structure that has more or less rotten wood in it. If you put on enough paint to fill all these rotten places this will aid in extending the life of the bridge and preventing fire, but you are not accomplishing anything when you put this paint on new timber, because the ordinary new bridge will not catch fire from a locomotive dropping coals when going over it.

Mr. Pickering:—I shall have to disagree with Mr. Killam on that. I have had fires on bridges within six months where the timber was practically new; also on bridges which had been build not over two years at the outside. It is a fact that some of these fire-resisting paints are preservatives as well as a protection against fire.

The President:—Is there anything more on this subject? We would like to have someone suggest a method for applying those samples.

Mr. Sheldon:—I would suggest that the committee formulate a method. They should use their judgment in the matter and give us a report of what they do.

Subject No. 2

DERRICKS AND OTHER APPLIANCES FOR HANDLING MATERIAL IN SUPPLY YARDS.

REPORT OF COMMITTEE.

After it was decided to carry this subject over from last year the committee sent one hundred letters to the various roads, asking for information concerning the extent to which derricks were used in supply yards. Fifteen replies were received to this letter. These replies, together with 31 received in reply to a circular sent out last year, were classified as follows:

15 roads report using no derricks of any description.

6 roads report that the store department handles all material, shipping it directly to each piece of work.

7 roads report using no derricks except steam wrecking derricks which are employed for loading heavy material.

8 roads report using steam derricks of various kinds made by several prominent manufacturers which operate under their own power.

6 roads report using derricks of various kinds built by their own forces.

1 road reports the use of an electric traveling crane.

2 roads report using common stationary derricks similar to the stone derrick with booms of sufficient length to reach one track on each side.

1 road reports using an ordinary stiff-leg derrick for handling heavy material.

The use of derricks and other appliances for handling material is divided in two groups; one for supply yards and the other for work of various kinds out on the road. The subject assigned to this committee limits its investigation to the first group and the application of such devices outside of supply yards is not considered here, although it is difficult in many cases to draw a dividing line between the two and a more complete report could have been obtained had the committee been allowed to discuss the entire subject. In many cases it is difficult to draw a line between the use of a derrick for the two classes of work, for a design is frequently used intermittently for both kinds of work and its adaptability for one may govern its selection, although it may possess certain disadvantages when applied to the other work. Bridge derricks can be used to good advantage in yards when not in service on the road, but as they are very often unavailable when required for yard work, they do not fill the requirements for this purpose.

The advantages of a derrick car and the kind of car most suited for any particular work, depend primarily upon the amount and kind of material to be handled. Where but a few cars of material are handled annually, it is not advisable to go to much expense to install the equipment unless the proportion of heavy material is large, in which case a stationary stiff-leg derrick may be advisable. However, as the amount of material becomes greater, the advantages of a derrick increase rapidly and the committee is strongly of the opinion that derricks of some type can be used with economy in a large number of yards where they are not so used today.

A derrick with four or five men will handle as much material as three times that number of men without such assistance, and in less time. Labor is becoming scarcer and more expensive each year. The use of proper

equipment will not only reduce the number of men required but will lighten their work and enable the foreman to secure better men for the money invested. The use of the less number of men in this work permits them to be employed in other gangs, in this way relieving to a limited extent the difficulties in securing men. Also, in handling heavy materials by hand the risk of injury to men is great and this risk will increase as the foreign labor becomes more generally employed in material yards.

Another important advantage with the use of derrick cars is the greater speed in unloading material. This is of advantage in releasing cars more promptly, which in itself is frequently an important item in times of car shortage as at the present time. The accumulation of demurrage charges is also to be avoided where much lumber, cement, iron pipe, etc., come in foreign cars. This time element is of special importance in loading large quantities of material which are frequently needed for construction work, or in emergencies such as washouts and wrecks. In such times, every hour saved is very important and proper facilities and equipment for handling material will expedite work greatly.

The type of derrick to be used is largely one of individual choice and depends upon the kind of material to be handled. Where very large quantities of material are handled, a traveling electric crane may be advisable. For yards of lesser importance, self-propelled steam derricks with booms of sufficient length to unload material from the car in advance of the derrick on the same track, and to pile materials for some distance on either side. may be advisable. A self-propelling car possesses the advantage that it can spot cars where wanted and then unload the material without requiring the attention of a switch engine, the latter usually resulting in more or less delay and being very expensive. Where a yard is not of sufficient importance to justify the expense of the above equipment, home-made derricks constructed of material on hand are frequently advisable. Derricks similar to the stone derrick with booms 30 or 40 feet long are recommended where much heavy material is to be handled.

Where stationary derricks are used, tramways should be built at right angles with the track to enable men to distribute lighter material out of reach of the derrick, leaving the space within reach for the storage of heavier material.

The committee has not been able to secure data relative to the cost of handling material, but from the letters received, it is estimated that the cost of handling heavy timber, iron and concrete pipe, etc., can be reduced 50 per cent by the use of proper equipment. Lighter material can also be handled at a saving of from 10 to 25 per cent.

J. N. Penwell,
A. S. Markley,
A. Yappen,
D. B. Taylor,
E. A. Stanley,
Committee.

DISCUSSION.

Mr. Penwell:—In the replies received to the circular letter the inclination has been to confuse bridge derricks and yard derricks, in about 75 per cent of the letters. As I understand it, the purpose of the subject was to study methods of handling material in the yard. Some yards depend on mounted bridge derricks to do most of this work. Our bridge derricks are out on the road perhaps three-fourths of the time, leaving the yard

unequipped for handling material in case of emergency, such as fires or wash-outs, when it is wanted quickly. There seems to be an inclination on many roads to transfer the handling of the material to the store department. On some roads the store department handles it exclusively.

The President:—Gentlemen, you have heard what Mr. Penwell has to say in regard to the report on Subject No. 2. I think the last four paragraphs on the second page were intended to be the committee's conclusion, although it does not say so.

Mr. Penwell:—That is the idea.

President:—Gentlemen, I would like to hear what you have to say in the matter of handling bridge timbers in the yard.

Mr. A. S. Markley:—Our main material yard is located at the same point where our general storekeeper is located. We have a derrick car with a double 7 in. x 10 in. cylinder, which is practically an Industrial pile driver without the leads, with a mast and boom put on it, the boom being about 34 or 36 ft. long. Originally it was chain-driven, but we had a great deal of trouble with the chains wearing and getting on top of the sprockets, so changed it to shaft-driven. It is self-propelling and will handle five and six cars on a level so that we can do our own switching. We handle material for $0.35 per M. I do not mean that we load one piece of timber for this figure, but this figure is secured by combining our work with that of the storekeeper, not by ourselves. When we are not using the derrick he is using it. I am confident that stringers, ties and large material can be handled for $0.25 per M. Many times when we want a rush order out on the road, three men will take the derrick and load the material we want. If we did not have the derrick, we might have to call in an entire gang, a distance, sometimes, of 100 miles or more, and in some cases it would take them two days to make the round trip. In seasonable weather the engine is fired up all the time and during the past year it has been in constant service. When we are not using it the storekeeper has it in use.

Mr. Pickering:—I would like to ask Mr. Markley the approximate amount of timber he handles per year with their derrick car in that manner.

Mr. A. S. Markley:—I do not have this figure. We kept a record of about seven or eight months and found the expense to be $0.35 per M. But you cannot handle or unload timber short of $1.50 or $2.00 and up to $5.00 per M. where you have to bring

a gang of men in from the road. We have a house carpenter and two roustabouts in our gang. We take the roustabouts out to handle the timber, and the engineer is responsible for the machine. We have a bed, a stove and a place to cook in our pilot car. The engineer lives here and takes care of the machine in transit.

Mr. Wenner:—Last week I had occasion to use one of these Industrial machines an entire day. I was unloading telegraph poles and the question has been raised of what it would cost to handle bridge material. I had six men with me and while I was crowded for time when I did this, I unloaded 48 pieces of 8 x 16, 24-ft. yellow pine in 30 minutes with that machine, and I picked up 30 pieces of second-hand material of the same size in 20 minutes. I think that the assertion Mr. Markley made regarding unloading or loading material for $0.25 per M. can be realized with a machine of that class, especially if one made it an entire day's work.

Mr. Pickering:—I am much interested in the question of handling material in supply yards. It is quite a problem with me. My yard, where the chief amount of my material is stored, is quite limited, and it is frequently necessary to pile the material very high. Possibly I use more material than a good many of these gentlemen do, because we have many wooden bridges. My requirements for the year 1913 are something over a million feet of hard pine on between six and eight hundred miles. The majority of this material is handled from one yard that is restricted in area. We have three derrick cars on the division and our aim is to keep one of these at headquarters all the time, but we find that it is impossible to do that as there is so much work. The division engineer has quite a bit of work which requires one of these derricks a good deal of the time, and it often happens that we have a vast amount of material coming in and at the same time we have got to ship some out. It is quite a question with us to handle our material economically in the yard.

Mr. Alexander:—We have a ditching machine made at St. Paul, Minn., which is a very good machine for many classes of work. We use that sometimes in our material yard, but we also have a Syracuse pile-driver with an improvised boom with which we have loaded much timber and which does the work well. However, as a general rule, we have nothing in our supply yard for loading timber, except a stiff-legged derrick or something

of that kind. Ordinarily, we store our supplies at different junction points over the road and it pays us better to do the loading with a few section men than to run a machine there and pay a train crew. This may not be logical, but it has seemed so with us.

The President:—Is there anything further on the subject?

Mr. C. H. Eggers:—On the Arkansas Division of the Rock Island we have seventeen miles of bridges. It is very seldom that we drive less than 1,500 piles a year and from that up to as high as 8,000 and 10,000 piles. In connection with our pile driver, we also have a pilot car with a derrick on it. We use the same engine we use on the pile-driver to pick up our timber and unload it. The store department handles the material in the yard altogether. They have a derrick car in the yard and can stack the material as high as they want to or handle any amount of it. I am now building another derrick car independent of a pile-driver altogether, for installing light iron work and other purposes for which it may be required. I think a derrick car is the only way to handle timber successfully.

Mr. P. Aagaard:—Supplies in our store yards are handled by the store department, mostly with cranes. We have, however, a small derrick connected with a locomotive which we use in some of our yards for picking up material.

Mr. C. E. Smith:—Great economy in the handling of material in supply yards can be shown by the use of a self-propelling locomotive crane. Such a crane, with a capacity of 10 or 15 tons and a 40-ft. boom, can be purchased for $5,000 or $6,000 and can handle anything in high piles and for a considerable distance from the track. It will also facilitate the loading of material in station order, which is done on many railroads. Where any special kind of material such as ties, bridge timber or track material, is to be handled, a self-propelling locomotive crane is a very good investment.

Mr. Staten:—It seems as though all those who have spoken have yards where they unload all their material and then ship it out again. On our road, we order it shipped where it belongs, and it is sent there directly from the mill. We keep very little material of any kind in the yard, and don't have much use for a derrick there. The emergency material is distributed along the road at the junction points. If we have a burn-out or similar trouble we load the material from the nearest junction point.

Mr. Smith:—I would like to suggest that the unloading and handling of material on the line as differentiated from handling it in the supply yard might be a good subject for a committee report next year.

Mr. Pickering:—I would like to say one word more about unloading and loading material in the supply yard. What Mr. Markley has said in regard to his material being shipped him is largely true with us, only we may get half a dozen cars today, and on each one of those cars will be all of the different sizes of material we have ordered, from two inch plank to 12 in. or 16 in. timbers. Then again, Mr. Staten lives down South where people are honest, but if we should distribute our material that way along our line, when we came to use it, there would be but little of it there.

Mr. Andrews:—It seems to me that we are straying away from the subject. As I understand this subject, it is one of handling material in the yard economically, not whether we store it along the line or keep it all in one yard. The best way to handle material must be governed in all cases by the local conditions at the yard and the amount of money that a railroad will permit one to spend in installing appliances for properly handling his material. In a great many places skids are erected out of old timber, on the level of the car floor, so that the bottom layer of the timber is always on a level with the floor. One can put up a stiff-leg derrick which in many ways is economical, but one must have an extra track for his cars, because unless it is placed high the stiff-leg derrick will not reach over the cars. A guy derrick with a long boom is practically on the same principle, but is a little more expensive and takes up more space on account of the placing of the guys. Frames with differential blocks are excellent and one can build them out of old railroad iron and old timber. Where the money will permit derrick cranes are excellent, but in my opinion, the most valuable of all is the self-propelling locomotive crane with a long boom which will place piles anywhere in the yard, pick up material from either side of the track and place it in the car in almost any position. A gentleman has said that those cars can be purchased for approximately $6,000. The interest on $6,000, with repairs, will probably run up to $600 annually. If one has a large amount of material to handle, it is a very easy matter to save $600. If he can show his general officers where he can save that amount of money and bring them a profit,

he will get the crane, but unless he can do so, he will not get it. You can use a locomotive crane for various purposes. For handling scrap, one can have it equipped with a generator at a slight expense, put magnets on it and pick up tons of scrap at a price that will be surprising. It is equally available for loading rails, pipe, and similar material around the yard. One can also run it into a freight yard close by and load merchantable material with it as we do in a number of cases. I simply mention the many methods that can be used and are used. All of those methods I mentioned are used on our road and in addition, we use them where we use main strength and awkwardness. I have tried to mention all the ways we handle material, not recommending any of them. The question resolves itself into what is the best method? That is what we want to get at and can be brought out best in the discussion if we confine ourselves strictly to the subject.

Mr. J. F. Parker:—I think that Mr. Markley brought out the right idea. The object we are aiming at is to find the best and the cheapest methods. We can all tell the story of how we do this work but if we do not give the cost of handling material by locomotive crane or of handling it by hand, we are not giving information that is going to be of any value. On the division where I am located, we have two locomotive cranes with 50-ft. booms. I think they were made by the Bay City Industrial Works. These cranes are used for all purposes, such as handling wooden bridge material, car wheels, and other material about the yards and shops that has to be loaded and unloaded. Also, at San Diego Bay we have a large material yard for ties and bridge timber. This material comes in by the cargo. We have steamers coming from Japan that carry a quarter of a million ties and they are all handled by the locomotive crane in the yard.

Mr. McNab:—On the Pere Marquette, we make an annual requisition every fall for the bridge material and piles we want for the next year, amounting to about 300,000 ft. per year. I have a yard at Waverly and when the material comes in, I keep two men there all the time loading and unloading it. When it arrives it is of course all mixed up. I have different skidways on a level with the cars, on which the material is unloaded. As it is required it is loaded and goes out on the road. We are not allowed to distribute material before the men are there to use it, on account of fires. I have always found it practically as

cheap as any other plan, to keep two men in the yard loading and unloading material.

The President:—Gentlemen, it appears to me that we have brought out about all the valuable information we can on this subject. We will pass on and I will ask you now what is to be done with this report? Shall we receive it as information, or shall we turn it back to the committee for enlargement? The committee has not made a distinct recommendation as to what is best under certain conditions. I think they ought to do so as that is part of the work.

Mr. Reid:—I don't think it is necessary for the committee to make a recommendation. I think, as Mr. Andrews said, that the method of handling material and the appliances for handling it will depend largely on the conditions in the various yards. The report has been turned in and printed and in that way has been received and has been discussed here. It seems to me the next thing to do, is to simply proceed with the consideration of the next report. I don't think it is necessary to take any final action on this report at all.

SUBJECT No. 4.

CONCRETE TANK CONSTRUCTION.

REPORT OF COMMITTEE.

In its 1911 report the committee attempted to show what had been done up to that time in this particular field of concrete construction and to determine whether or not the concrete tank was practical and could be recommended for railway service. Examples of tanks built for railway and other purposes were given; specifications were quoted either wholly or in part, and it was shown that the concrete tank is practical and desirable where a permanent tank is contemplated. It is becoming more common to place the tank farther away from the tracks at railway water stations and to deliver water to engines through pipe lines and stand-pipes, thereby making the water tank a more permanent structure. This decreases the necessity for a structure that can be moved on account of track changes and make the concrete tank possible.

The two great arguments in favor of the concrete tank are permanence and minimum cost of maintenance. When the life of the tank is taken into consideration the latter will more than offset the increased cost of construction. The concrete tank is more costly than the wooden or steel tank but the steady increase in the price of lumber and the more improved methods of concrete construction are steadily reducing the difference.

The committee is of the opinion that when subjected to the severest winter weather the concrete tank will stand up better than tanks of other materials. The above statement is based on conversations with various engineers who have had experience in water supply, and at present cannot be substantiated by facts. However, some concrete tanks are located where they are subjected to severe freezing weather and others are being considered so that it will not be long before this point can be determined definitely.

Many arguments are advanced against the concrete tank, the chief one being that poor workmanship will result in a defective tank and this cannot readily be discovered or remedied. The statement is true, but it is also true of all other forms of construction. The remedy is careful, conscientious and competent supervision in selecting materials and doing the work.

DESIGN.

When contemplating the building of a concrete tank the design must first be decided upon. As this association is more directly concerned in the construction work we will simply refer to the 1912 report of the American Railway Engineering Association, in which the subject of design and specifications is very completely covered.

Tanks may be divided into three classes:

(*a*) A hollow cylinder of which the base forms the floor, either resting on the ground or under the surface of the ground. To this class belong large tanks or reservoirs for conserving large quantities of water and those located on elevated places.

(*b*) A hollow cylinder, rather tall and having a diaphragm some distance above the ground surface which forms the floor of the water reser-

voir. The lower portion of the cylinder forms the tower and the enclosed space can be utilized for pumping machinery or for storage purposes.

(*c*) Elevated tanks on towers. As a rule a circular tank is decided on because the stresses are more easily provided for, but there are cases where for local or other reasons it is necessary to adopt square or oblong designs.

Material.

There is no line of work in the broad field of concrete construction in which the care and judgment used in the selection and application of the materials is of more importance than in tank construction. Only cement of approved brands should be used. It should be delivered on the job in original packages and each consignment should be carefully tested. The sand, gravel and crushed stone must be carefully examined for impurities, and all such containing impurities must be rejected. The sizes of the various materials should be carefully considered and the proportions to be used determined in order that the resulting concrete will be as dense and watertight as possible. Much has been written of this particular feature in connection with concrete work in general, therefore, it is not necessary for the committee to elaborate upon it. Our purpose is to emphasize good workmanship.

Mixture.

There seems to be a wide difference of opinion regarding the kind of a mixture that will produce the most compact and impervious concrete. Most specifications call for a wet mixture, yet occasionally a dry mixture is specified. In regard to the latter, Mr. L. Heidenreich says in his Engineer's Pocket-Book of Reinforced Concrete, "The author prefers for tanks a rather dry mixture of one part cement to four parts coarse sand well tamped. If a wet mixture is used the mortar or concrete is apt to contract in setting, thereby causing initial compressive stresses in the steel reinforcement. When the tank is filled the concrete will crack in various places until the steel receives its tension stress. This is the common cause of leaky tanks, which must be plastered or painted afterwards." The decision as to what is best must be left to the engineer and is controlled by the material available and his past experience.

Waterproofing.

Regardless of whether any special means are employed in waterproofing tanks, the careful selection and grading of the aggregate with care in the placing of the same should be followed as given under the head of "Material."

There are various methods of waterproofing concrete in use today, such as mixing a certain percentage of crude oil with the concrete or adding a paste, powder or lixiviating water to the concrete and mixing it with the cement, the mass of the concrete as a whole or with the water. There is no doubt that any of these methods will produce an impervious concrete. However there is always a doubt whether the addition of any extraneous substance to the cement will not in time injure the concrete.

With properly graded material and careful placing of the same it is possible to get a concrete that would not require more than an application of bituminous paint on the inside to prevent any seepage of water.

The cement gun has been used quite successfully in waterproofing reinforced concrete reservoirs in California. It was used in giving a coating to the bottom and sides of the large Twin Peaks reservoir which was built for the city of San Francisco. This reservoir is 370 ft. long, 285 ft. wide and 27 ft. deep, and has a capacity of 11,000,000 gallons. It is divided into two parts by a partition wall in order that one-half of the reservoir may be cleaned and repaired without leaving the city unprotected.

When the reservoir was first built it was found that there was consid-

erable leakage and the engineers decided to trv the cement gun. A mixture of one part Portland cement to three parts of graded sand was used and to this was added a small quantity of hydrated lime. The coating put on by the cement gun varied in thickness from one-quarter of an inch at the top to one-half inch at the bottom. The concrete was kept thoroughly wet before the gunite was applied, and was also kept wet for several days afterwards. As soon as the work of the cement gun was finished the reservoir was filled and while, at the end of 24 hours a slight seepage showed on the wall, this disappeared at the end of 48 hours and the coating is apparently a success.

The cement gun has also been used in California in coating tanks used for the storage of slop distillate. This is a comparatively new process and is well worth trying where the apparatus is available.

Cost.

The first question that naturally occurs to one when a concrete tank is mentioned is, "What will it cost?" We have not collected many data on the subject, but have tabulated what we have received in such a manner as to enable one to make an approximate estimate should he have occasion to build a tank under similar conditions.

The concrete tank costs more than other tanks, but the first cost ought not to be the governing feature. A careful comparison should be made of different designs and styles of construction of tanks having the same capacity and serving the same purpose and the cost per annum in each case arrived at. The cost per annum is the average cost per year for the life of the structure.

The total cost is made up of the original cost of the structure; interest on the original cost for a period equal to the life of the structure; the total maintenance charges during the life of the structure; the interest on the maintenance charges from the time expenditures were made until the end of the life of the structure; and the risk or liability of destruction by storm or fire, whether covered by insurance or not. The total of these items divided by the number of years of life of the structure equals the cost per annum.

The building of concrete tanks is a comparatively new field and sufficient time has not elapsed since the last report to bring forth any new developments.

W. F. Strouse, assistant engineer, reports that the tank built at Sir Johns Run, W. Va., for the Baltimore and Ohio by the Steel Concrete Construction Company, has passed the severe winter of 1911-12 without showing any bad effects and that only a slight sweating or seepage has appeared. This seepage is a common occurrence and begins to show soon after the tank is first filled. This has usually disappeared after a few weeks, and tends to prove the theory, that, whether it is caused by the porousness of the concrete or by cracks developing because the concrete is stressed beyond its elastic limit, precipitates from the water soon fill up the interstices and the tank becomes absolutely water tight.

Another tank has since been built by the B. & O. at Chicago Junction, Ohio, having the same capacity, 100,000 gallons, and the same diameter, 25 ft., but the height of the tank bottom above the base of rail is 50 ft. instead of 30 ft. as at Sir Johns Run. The Chicago Junction tank is really a three story structure, the basement being used as a pump room, the second story for storage and the third for water. This tank was also built by the Steel Concrete Construction Company of Pittsburgh. Both tanks were designed and constructed under the supervision of F. L. Stuart, Chief Engineer.

In the Engineering News of February 1st, 1912, appeared an article on the failure of a steel stand pipe at Sheboygan, Wis., on the evening of January 15, 1912. This stand pipe was erected in 1887 at a cost of $13,000, was 140 ft. high above foundation and was 20 ft. in diameter. The failure was due to ice forming in the stand pipe on account of two weeks of unprece-

Concrete Tank at Sir John's Run, W. Va., Baltimore & Ohio R. R.

dented cold weather. Because of the large amount of water consumed the pumps were run continuously to keep up the supply, and as a consequence there was no circulation in the stand pipe and it acted merely as a balance on the system. An ice cap formed at the top, a thick layer of ice formed at the bottom and the intervening space was partially filled with a circumferential lining about 2 ft. in thickness. The amount of ice which fell with the tower is estimated at 950 tons. Fracture occurred at the bottom, parts of the lower rings being thrown 100 ft. away from the foundation in the direction opposite to which the tower fell. If this had been a reinforced concrete tank this collapse could not have occurred.

Mr. L. J. Mensch, contractor, of Chicago, has recently completed the construction of a 600,000 gallon reinforced concrete tank for the city of Berlin, Ontario. The elevated tank is supported by a reinforced concrete tower or shell, 12 in. thick and 80 ft. high, resting on a circular foundation 13 ft. wide. The tank is 52 ft. in diameter and is designed to carry a depth of water of 45 ft. It is surmounted by a dome-shaped concrete roof. The bottom of the tank is a double dome similar in design to the tank for the Chicago City Railways Co., previously described. The two domes are so designed that the thrusts at their juncture nearly balance when the tank is filled. When the tank is empty the thrust of the outer dome is much greater than that of the inner dome and this is taken care of by an increased section of concrete. The section of concrete is also materially increased at the junction of the outer dome and the shell of the tank.

The reinforcement of this tank consists of high carbon steel square bars of plain sections. The mixture of concrete in all portions of the tank in

Concrete Tank at Sir John's Run, W. Va., Baltimore & Ohio R. R.

direct contact with the water is 1: 1: 2, while in other portions of the structure the mixture was proportioned in the ratio of 1: 2: 4.

The lower shell or tower was built by using wooden forms 6 ft. deep, and the concreting was done at the rate of from four to six feet per day. The forms for the tank proper were in sections 3 ft. 1 in. high and 8 ft. long; the outside forms were kept from spreading by using tank hoops. Two sets of forms were used, one on top of the other, in order that one set of forms would serve as a support for the next while being placed. A dam of sheet steel six inches wide was imbedded three inches in the concrete at the end of each day's work.

This tank is of special interest because it is the most recent structure of this kind of which we have been able to obtain a record,—having been begun in August and completed the latter part of November of this year. It is the largest elevated reinforced concrete water tank ever built and is also the largest elevated tank of any kind in actual service. An elevated steel tank is in existence, having a greater capacity but it has never been put into use. The construction of this tank was successful and showed no sign of leakage or seepage after being filled with water.

An elevated concrete tank of an unusual design has been built by the Chicago City Railways Company to provide pressure for its shop sprinkler system. It has a capacity of 100,000 gallons, is 30 ft. in diameter and 20 ft. high and the tank bottom is 75 ft. above the ground level. The double dome bottom is entirely different from that of other tanks mentioned in this report.

An eight inch wall was used but the engineers say they would reduce this to six inches if another tank were built. The roof is of concrete and spherical in shape, and the tower consists of four posts spread to 42 ft.

Concrete Tank at Sir John's Run, W. Va., Baltimore & Ohio R. R.

10 in. centers at the ground level in order to clear the pump house below. The tank was designed by Hugo Schmidt, superintendent of buildings for the railway company, and built by L. J. Mensch, contractor.

Last year the city of Norway, Mich., built a concrete tank in connection with its gravity water supply system. The tank has a capacity of 300,000 gallons, is 43 ft. high with an inside diameter of 35 ft. and has walls 12 inches in thickness. The tank rests on a solid rock base and is entirely above the ground. The following is quoted from Engineering and Contracting with the permission of L. R. Howson, resident engineer for Alvord & Burdick of Chicago, who contributed the article:

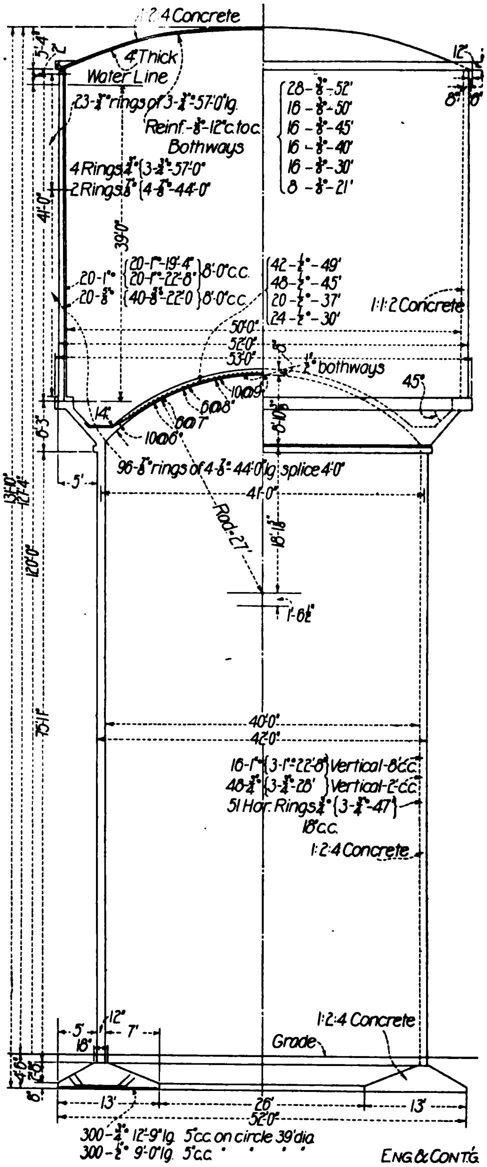
"The forms were built in sections 5 ft. in length by 3 ft. in height, and two complete inside and outside rings were used. The forms were of 1-in. clear lumber, dressed on one side and two edges and nailed into a vertical position. Before the forms were used they were given two coats of heavy black oil to prevent the cracking and swelling of the wood. Each time the forms were shifted they were given a coating of paraffine oil to keep the concrete from adhering to them, care being exercised to allow no oil to drip on the concrete joint surface and destroy the bond. The forms were banded together with two rings of ¾ in. rods drawn tight with turnbuckles. The appearance of the finished tank would have been improved by using a light galvanized lining for the outside forms. Before the walls were started, a complete inside framework to carry the dome and bracing was constructed, and a tower to carry the hoisting cages.

"The steel was of the plain circular bar type, having an elastic limit of 50,000 lbs. per sq. in. It was originally intended to use "deformed" bars, but the great difficulty experienced in bending these bars in a plane caused the adoption of the plain section. The bars were 1-in. and ⅞-in. in diameter and were placed in two circles for the bottom 18 ft. of wall, the upper part having but one ring. One-half inch circular rods were placed vertically at 15 ft. intervals to serve as tie rods. The bottom was reinforced in two directions to care for temperature stresses. The dome was reinforced with woven wire. Special care was used to keep the bars a sufficient distance apart to insure a perfect bond on all sides of the bar. The joints of the bars were made without the use of clips, the bars being lapped 50

Reinforced Concrete Tank, Berlin, Ontario, Capacity 600,000 Gallons.

diameters and held apart at least one diameter. All joints were staggered one-eighth the circumference and two bars made one ring around the tank. Care was used throughout the work to prevent the shifting of forms or of steel after the concrete had begun to set. The steel was all bent to shape on the ground witn templates and an eye bar at a cost of 50 cents per cu. yd. of concrete. Bending and placing the steel cost $5 per ton. The chief details of the design are shown in the accompanying drawing.

The concrete was a 1: 1: 2 mixture; earlier difficulties with a 1: 2: 4 having demonstrated that the additional expense of a 1: 1: 2 mixture in waterproof work is well justified. The brand of cement was the "Huron" and tests of samples sent to Robt. W. Hunt & Co. showed a neat strength oı 398 lbs. per sq. in. in 24 hours, and 760 lbs. per sq. in. in 7 days; a 1: 3

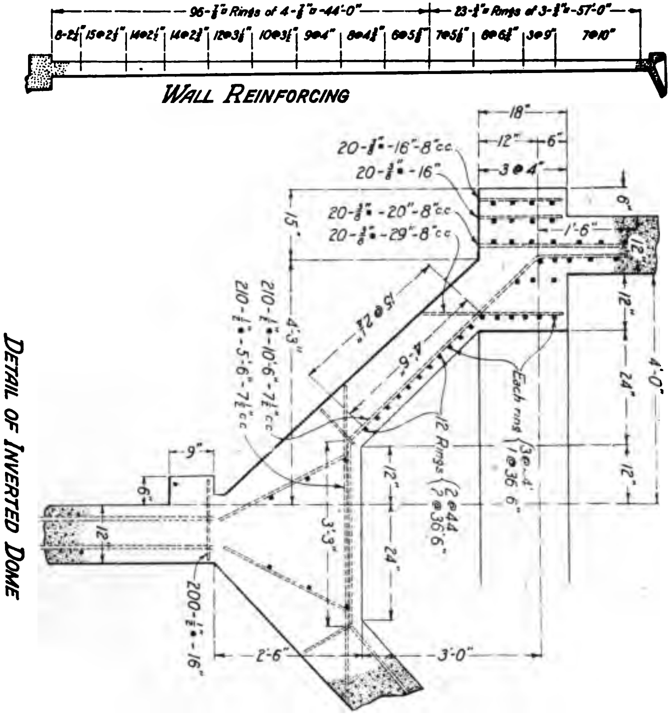


Reinforced Concrete Tank, Berlin, Ontario, Capacity 600,000 Gallons.

mixture tested 123 lbs. per sq. in. in 24 hours and 373 lbs. in 7 days.

"The stone was specified as between 1/8 in. and 3/4 in. in size, and was at first obtained from local gravel pits, but due to the very small percentage of material screened out of the required size, crushed stone was shipped from a point nearly 300 miles distant, and this item of stone cost materially raised

LOCATION	NO.	SIZE	LENGTH	REMARKS
ROOF	28	3/8"•	52'	
	16	"	50'	
	"	"	45'	
	"	"	40'	
	"	"	30'	
	8	"	21'	
	12 8	3/4"□ 7/8"□	57' 44'	
SHELL	69	3/4"□	57'-0"	
	384	7/8"□	44'-0"	
	20	1"•	19'-4"	
	20	"	22'-8"	
	40	5/8"•	22'-0"	
RING AT BASE OF SHELL	86	7/8"□	44'-0"	AND 6-7/8"□-36'-6"
	20	3/8"•	16"	
	"	"	20"	
	"	"	29"	
INVERTED DOME	33	7/8"□	44'-0"	LOWEST RINGS 2-44' 2-36'-6"
	27	"	36'-6"	NEXT 3 RINGS 3-44' 1-36'-6"
	210	1/2"•	10'-6"	BENT
	"	"	5'-6"	
	420	1/4"•	2'-0"	BENT
INNER DOME	42	1/2"•	49'	
	48	"	45'	
	20	"	37'	
	24	"	30'	
SUPPORTING SHELL	24	7/8"□	36'-6"	
	200	1/2"•	16"	
	48	1"•	22'-8"	
	144	3/4"•	28'-0"	
	153	"	47'-0"	
FOOTING	300	"	12'-9"	
	300	1/2"•	9'-0"	BENT



WALL REINFORCING

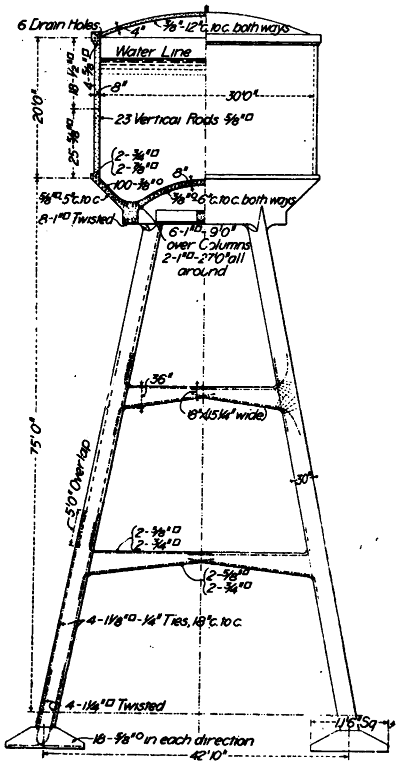
DETAIL OF INVERTED DOME

Reinforcement for Concrete Tank at Berlin, Ontario.

Elevated Concrete Tank with Double Dome Bottom, Chicago City Railways Co., Chicago, Ill.

the concrete coat. Excellent sharp clean sand was found at a pit near the standpipe site.

The cement was mixed with 10 per cent by volume of hydrated lime for waterproofing. All mixing was done by hand labor and great care was used to see that the mixture left the board as uniform as possible. The concrete was all a wet mixture, but not so sloppy that the stone would settle to the bottom when the concrete was spaded. Three feet of concrete wall was placed per day, the rest of the time being used in raising the lower set of forms and placing the steel ready for the next day's work. Working in this way, the difficulty of securing watertight joints is much greater than where only brief rest periods are allowed between pourings. Before placing concrete, the top of the previous day's work was roughened and cleaned,



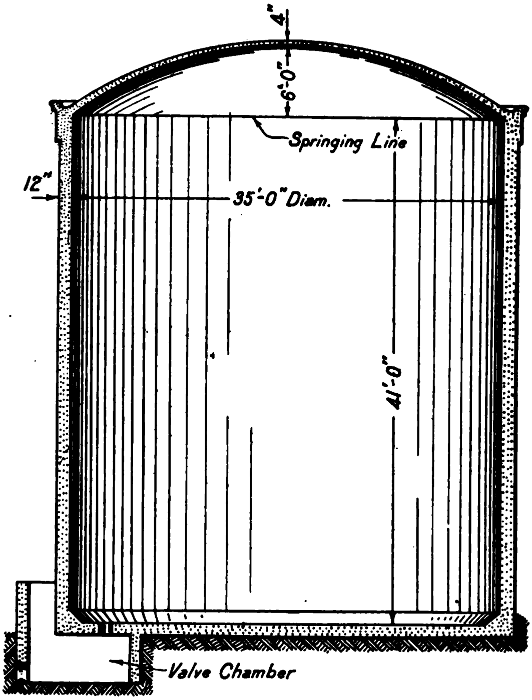
Concrete Tank for Chicago City Railways Co.

then covered with a ½ in. layer of 1: 1 mortar in which the cement contained 10 per cent hydrated lime upon which the concrete was placed. Both form faces were spaded carefully with mortar hoes which had been straightened, and upon the removal of the forms no stones were visible at the surfaces of the walls.

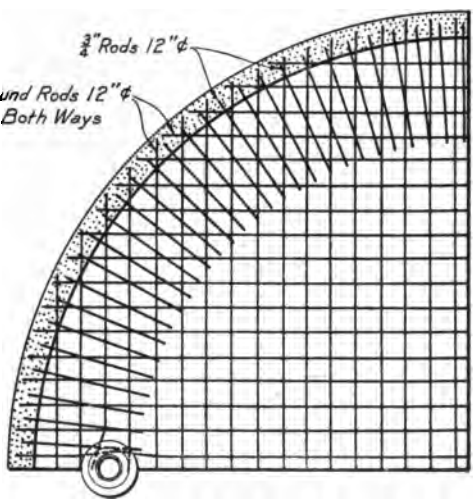
"The roof is a reinforced concrete dome 4 in. thick at the crown and 6 in. thick at the springing line, and reinforced with American Wire Company's woven wire. The forms were supported upon a series of trusses which rested upon the inside scaffolding for the walls. The face boards of 1-in. lumber were well soaked and drawn to the spherical surface of the dome. The concrete for the dome was a 1: 2: 4 mixture and was mixed quite dry, so that it could be placed upon the spherical surface without sliding. A low parapet was constructed and the roof drained to one point at which was located the overflow of the tank which also carried roof drainage.

"After the entire tank was completed it was given three coats of plaster inside, mixed in the proportions of 1 part cement, 1½ parts sand, ¼ part hydrated lime and hydratite. The first coat of ¼ in. thickness was applied rough, and while still wet was covered with a second coat about ⅛ in. thick which was brought to a wood floated surface; this was next gone over with a brush coat and brought to a very smooth troweled finish. The plaster was applied in circumferential strips 6 ft. in height, and the cost of the three coats per sq. ft. of surface was 7¼ cts.

Reinforced Concrete Tank for Gravity Water Supply, Norway, Mich.

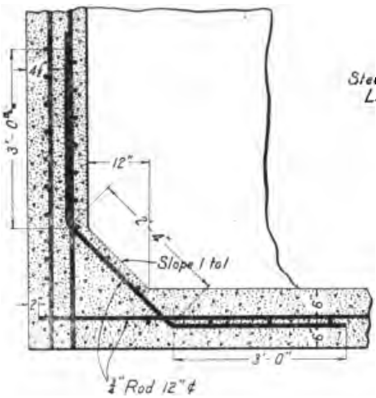


Vertical Section

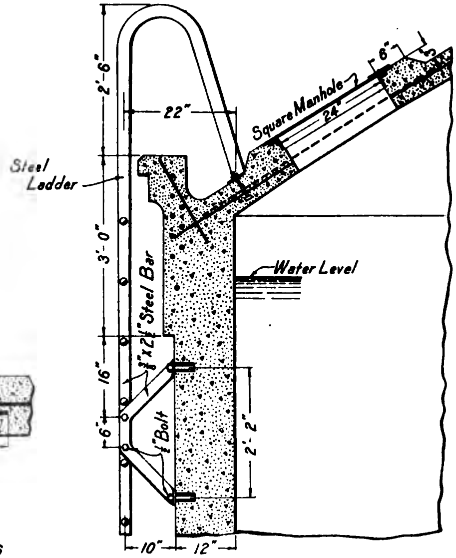


Bottom Reinforcement.

Reinforced Concrete Tank for Gravity Water Supply, Norway, Mich.



Bottom & Wall Connections



Ladder & Manhole Details.

Details for Concrete Tank, Norway, Mich.

"Upon the completion of the entire tank, it was filled and allowed to stand 48 hrs. and no change in the water level could be detected. For the first week, however, some sweating was noticeable, but in only one place was it of enough consequence to gather and flow, and this evaporated before it was 3 ft. below where it first appeared. No attempt was made to remedy the sweating other than emptying the tank and refilling in two days, but within ten days all discoloration disappeared and no sweating has since been apparent. The tank received a severe winter's test during the past winter when ice over 2 ft. in thickness covered the top and extended around the side walls of the tank well.

"The more successful waterproof construction effected in this tank using a 1: 1: 2 mixture than in others built under the same supervision and care but of 1: 2: 4 mixture, seems to justify the additional expense for cement. The plaster is also an effective 'waterproofing aid' although how large a part of the good results obtained here, are due to the plaster and the 1: 1: 2 mixture respectively is a matter of personal opinion. Results secured by plastering other large tanks of 1: 2: 4 mixture would seem to indicate that the mixture was more important than the plaster face."

The total weight of the reinforcing material in the tank is 45,400 lbs. The outside surface of the tank was not given any treatment except that rough places where the forms were joined were chiseled off to give a smooth appearance. The tank is quite a distance from the town and the nearest street is about 300 ft. away. From that distance the tank presents a smooth appearance. The plans were made by Alvord & Burdick, hydraulic and sanitary engineers of Chicago, and L. J. Mensch was the contractor.

In connection with the water power developments at Ephratah, New York, built by the Mohawk Hydroelectric Company, a surge tank of concrete was constructed. The following quoted from the Engineering Record of November 15, 1911, is of interest in explaining the mixing of concrete and the water proofing: "SURGE TANK:—The surge tank is a cylindrical

concrete structure 25 ft. in diameter and about 50 ft. high. The concrete was mixed with an excellent grade of sand and with crushed stone that passed through a 1-in. screen, averaging about ½ in. in size. The voids in this stone were determined and sand proportioned slightly in excess. The voids in the sand were determined and cement slightly in excess added. The resulting mixture was approximately 1 part cement, 1.8 parts sand and 2.5 parts broken stone. The forms were removed the day following the placing of the concrete, and the interior painted, while still green, with two coats of neat cement wash. Although the tank was constructed in cold weather, requiring protection by canvas and the use of steam coils on the fresh concrete it is said that an absolutely tight job was obtained."

In the Railway & Engineering Review of Dec. 5th, 1911, is a description of a fuel oil installation on the Great Northern Ry. and the drawings show concrete sumps built in connection therewith. These sumps are 22 ft. inside diameter, 7 ft. high and have a capacity of approximately 18,000 gallons. The article does not explain the construction of these sumps, but the drawings shown indicate clearly the manner of placing the reinforcement, and for that reason they are of interest.

The town of Waverly, Ohio, built a concrete water tower with a capacity of 120,000 gallons, beginning the work late in the fall of 1910. When about half finished the extreme cold weather obliged them to stop work and it was completed in February, 1911. The tests made in May 1911, were very satisfactory and showed no ill effect on account of the interruption.

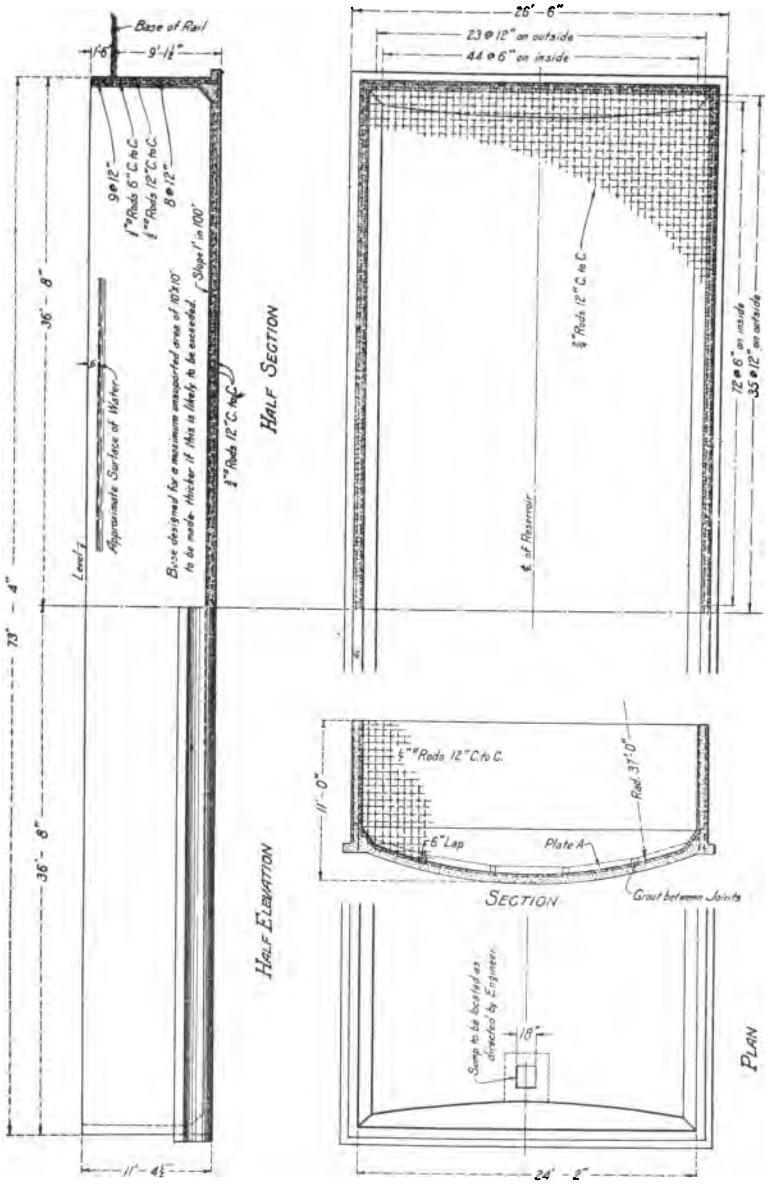
This tower rests on an octagonal foundation 22 ft. in diameter and 7 ft. deep, which also forms the floor of the tank. Horizontal reinforcement was placed when within 18 inches of the top of the foundation consisting of ⅜ in. rods bent at right angles, the horizontal part being about 4 ft. long, spaced 18 inches and about 4 inches from the outer side of wall. A ⅝ in. rod was placed in the angle and the perpendiculars were wired to it.

Drawings are submitted showing details of construction of two reinforced concrete reservoirs built by the Chicago, Milwaukee & St. Paul. The one built at Milwaukee Shops, Wis., in 1906 is rectangular in shape, 22 ft. 8 inches wide, 73 ft. 4 inches long and 9 ft. deep with a capacity of 100,000 gallons. It is placed below the surface of the ground and has proven very satisfactory. The second is a circular concrete reservoir 40 ft. in diameter and 12 ft. deep with a capacity of 100,000 gallons, now under construction at Godfrey, Ill. Another tank was built at Corliss, Wis., in 1910, which is 35 ft. in diameter and 9 ft. deep, with a capacity of 60,000 gallons.

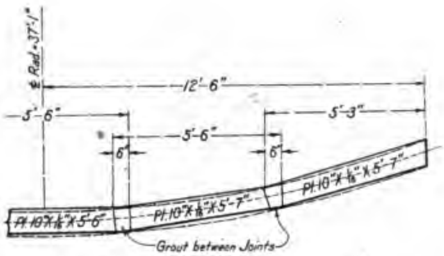
The Baltimore & Ohio has recently completed two concrete water tanks 55 ft. in diameter and 12 ft. in depth at the new water station, which will be known as Miller, W. Va., located at the west end of the Cherry Run Yard. These tanks have a capacity of about 200,000 gallons each and were constructed in accordance with the details shown on the accompanying plan. The location is along a steep hillside on a shelf or bench formed by cutting away the earth and rock at an elevation of about 50 ft. above the track level, where the penstocks are located.

The site was levelled down to the established elevation by cutting away the earth and rock where it was above grade and by building up concrete ribs to support the bottoms where it was below. About one half of the total area occupied by the two tanks is solid rock, and the balance compact clay with the concrete ribs above mentioned which were carried down to a satisfactory bearing material.

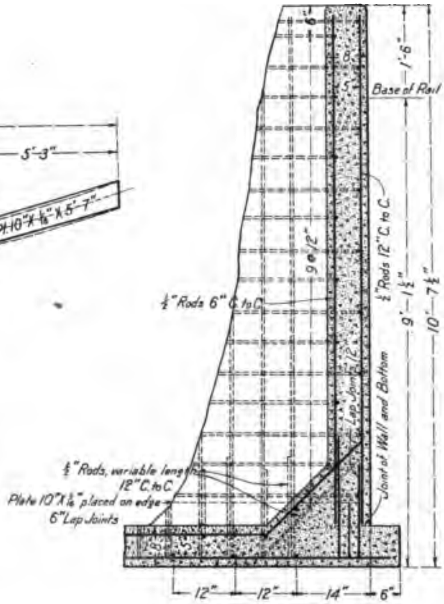
When the site was ready, forms were constructed for placing the bottoms of both tanks. The concrete for each bottom was placed at one pouring. Short sections of reinforcing rods were bent and set up in the concrete in the location of all columns and in the grooves around the outer edge of the bottom to which to splice the reinforcing material for columns and outer walls. As soon as the concrete had properly set, forms and reinforcing rods were set up for the wall of one tank, the concrete for which was all placed at one operation without interruption. The columns, beams and roof were not poured until the walls were sufficiently set to allow the



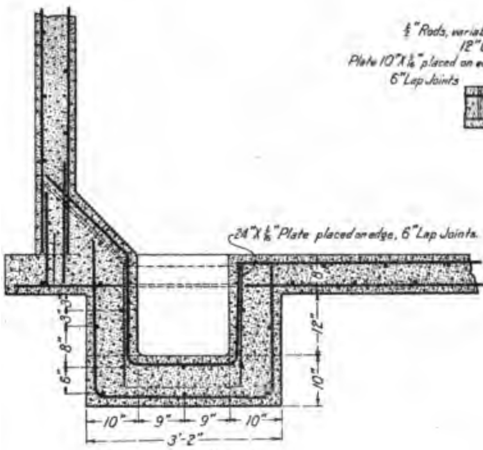
Concrete Reservoir, 100,000 Gallons Capacity, C. M. & St. P. Ry., at Milwaukee, Wis.



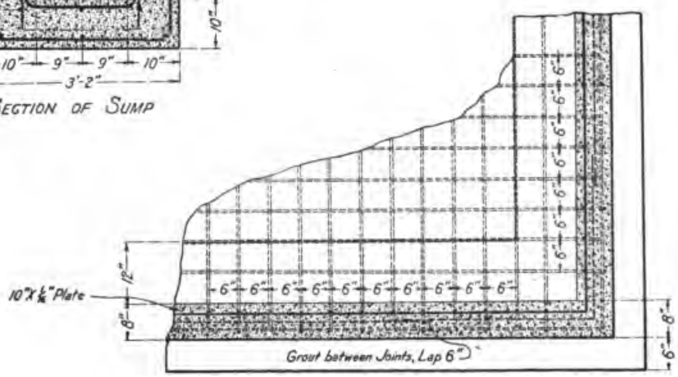
DETAIL OF PLATE "A"



SECTION OF WALL.

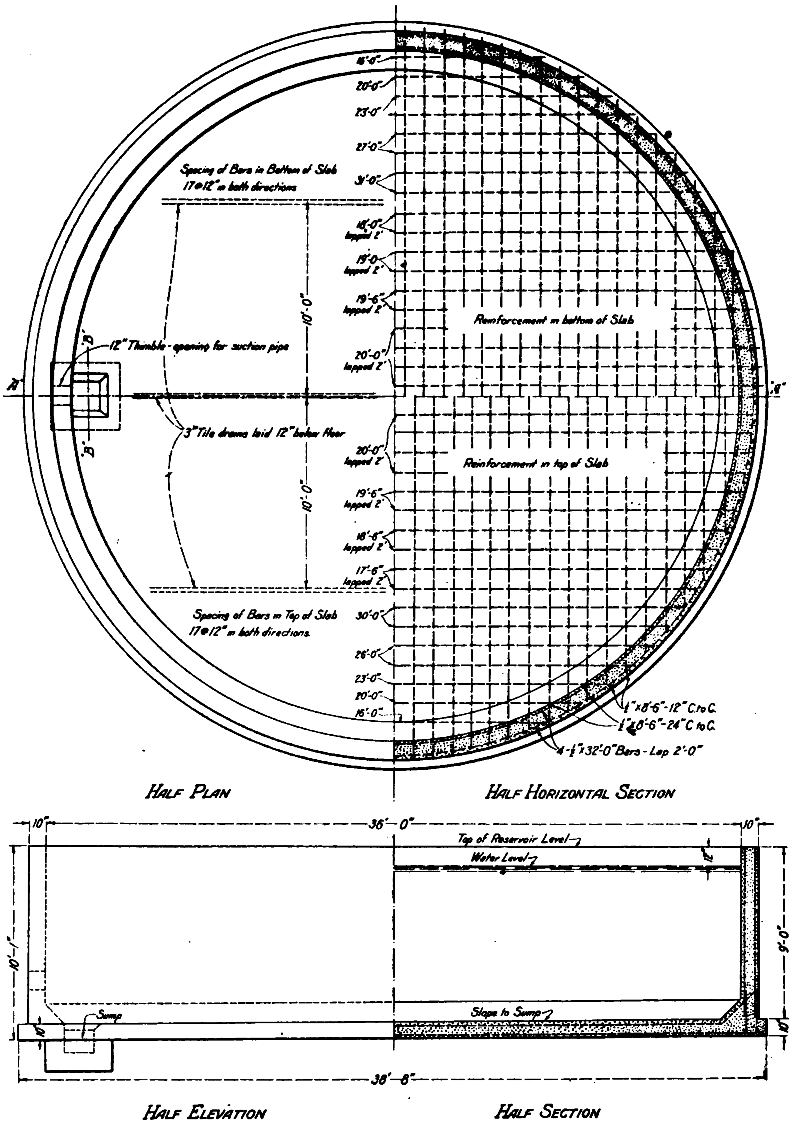


SECTION OF SUMP

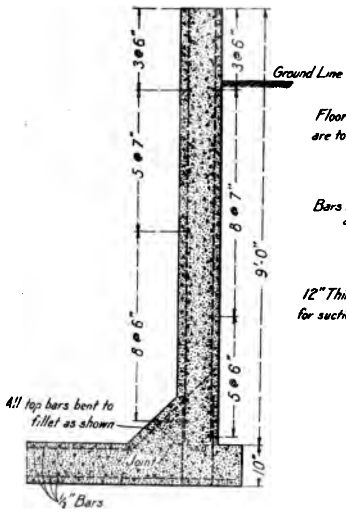


PLAN

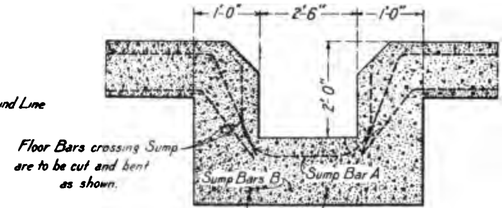
Details Concrete Reservoir at Milwaukee, C. M. & St. P. Ry.



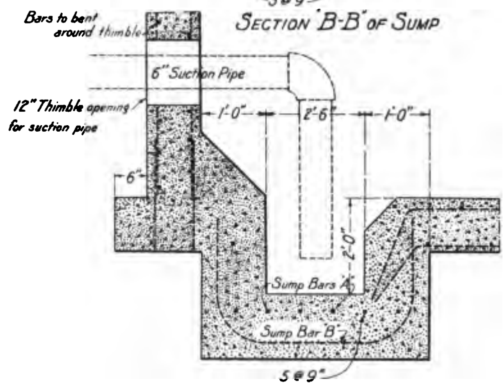
Concrete Reservoir at Corliss, Wis., C. M. & St. P. Ry., Capacity, 60,000 Gals.



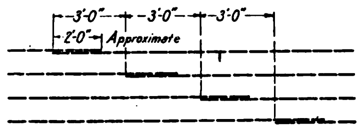
SECTION OF WALL



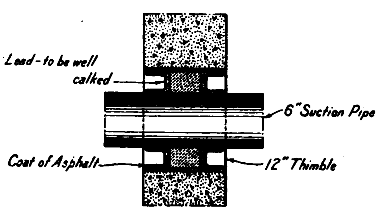
SECTION "B-B" OF SUMP



SECTION "A-A" OF SUMP.



LAP OF BARS IN WALL.

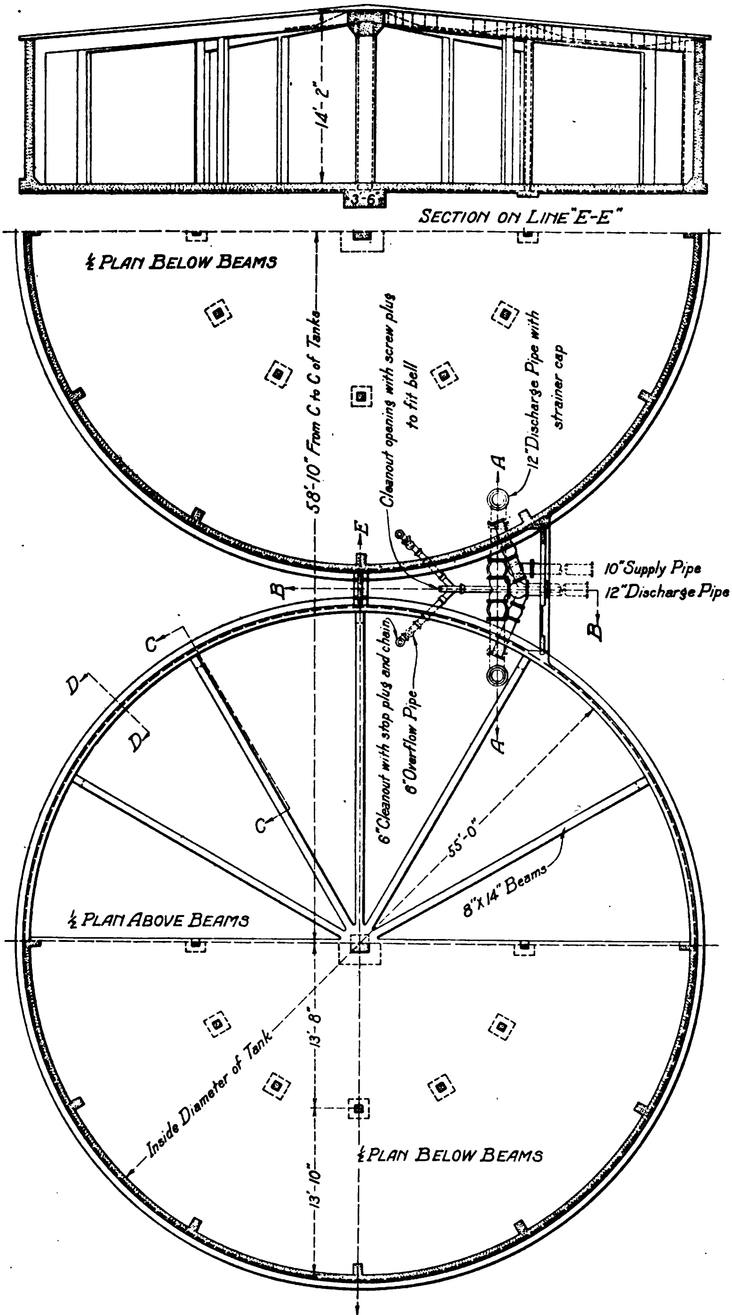


DETAIL OF WALL AT SUCTION PIPE

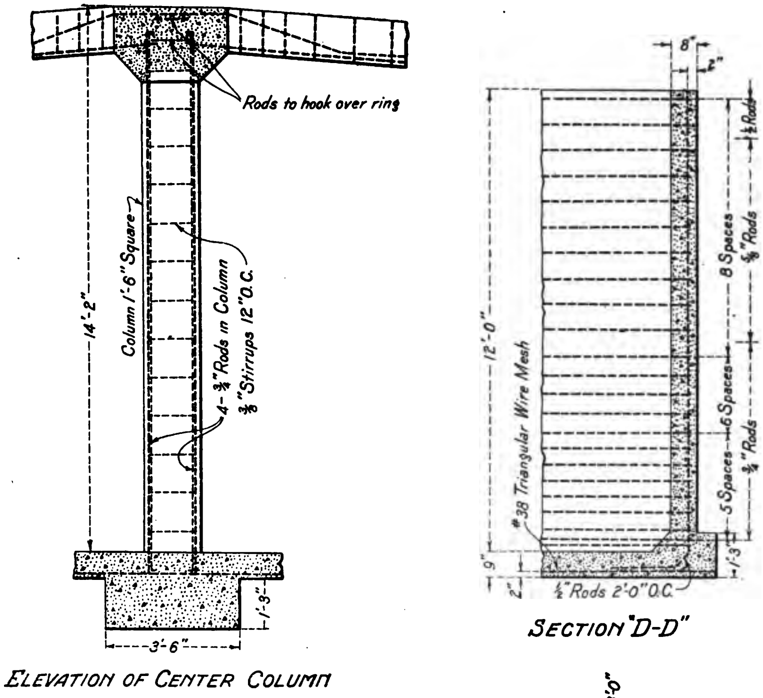
BILL OF BARS

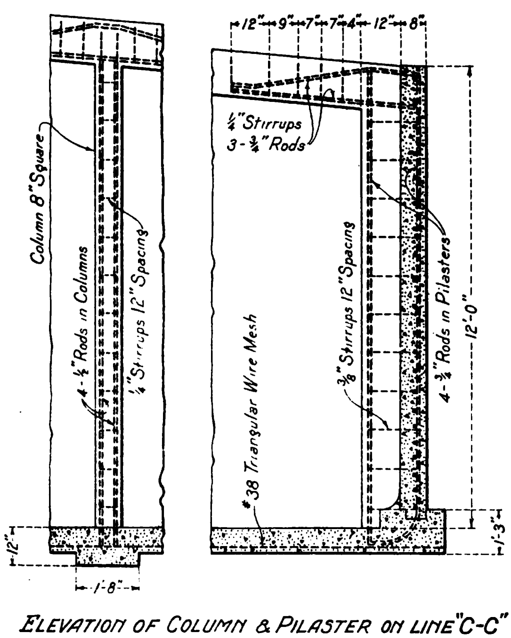
	Nº	Size	Length	Remarks
FLOOR	6	½"	6'-6"	Sump Bar "A"
	6	"	9'-0"	" " "B"
	4	"	16'-0"	Transverse in bottom
	4	"	20'-0"	" " "
	8	"	23'-0"	" " "
	8	"	27'-0"	" " "
	8	"	31'-0"	" " "
	16	"	18'-0"	" " "
	16	"	19'-0"	" " "
	16	"	19'-6"	" " "
	32	"	20'-0"	" " "
	4	"	16'-0"	" " Top
	4	"	20'-0"	" " "
	4	"	23'-0"	" " "
	8	"	26'-0"	" " "
	8	"	30'-0"	" " "
	16	"	17'-6"	" " "
	16	"	18'-6"	" " "
	16	"	19'-6"	" " "
	32	"	20'-0"	" " "
	176	"	2'-0"	Dowels
WALL	68	"	32'-0"	Inside Wall
	68	"	32'-0"	Outside Wall
	176	"	8'-6"	Vertical

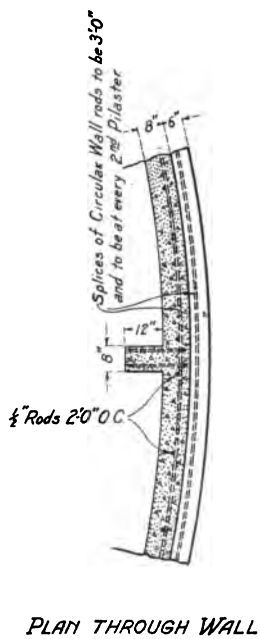
Details, Concrete Reservoir, Corliss, Wis., C. M. & St. P. Ry.



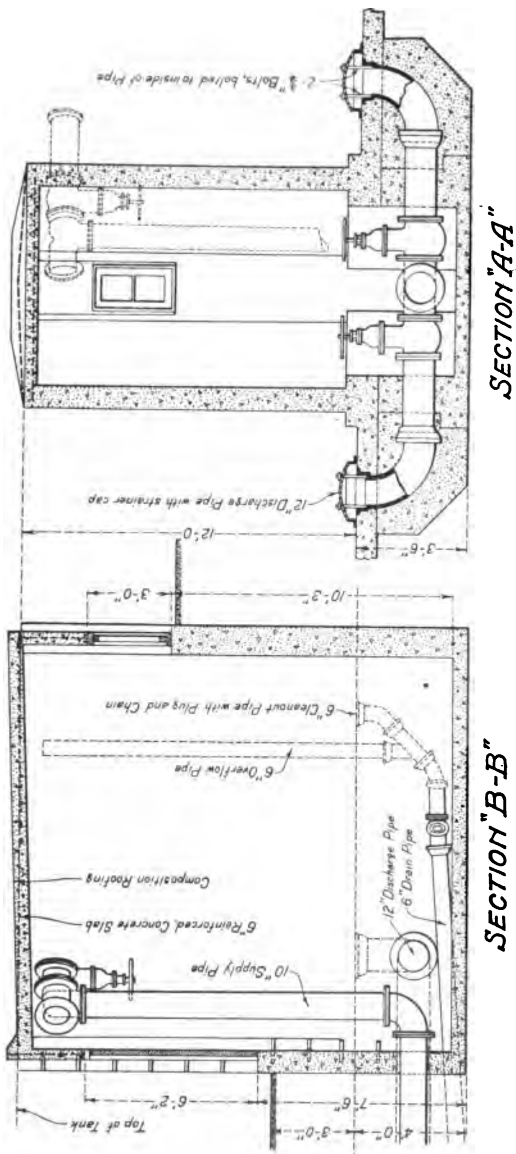
Twin Concrete Reservoirs, Miller, W. Va., B. & O. R. R.





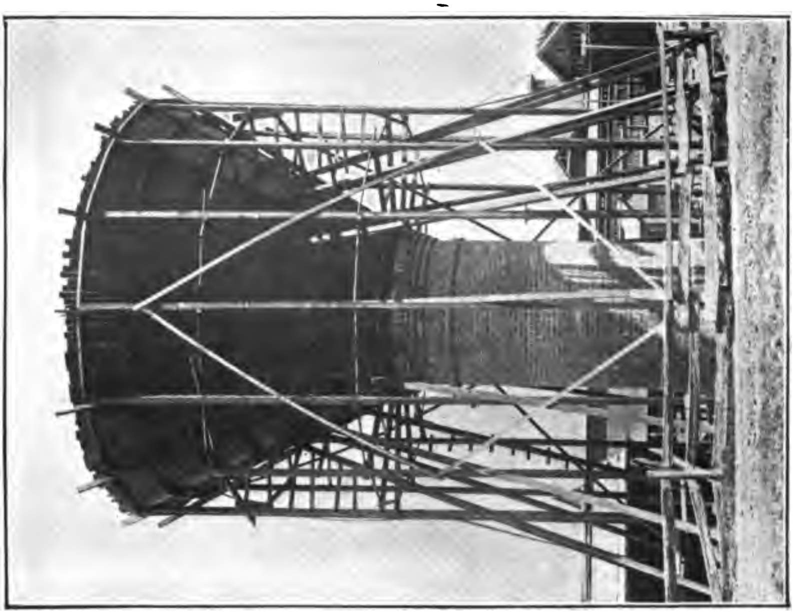


Details, Twin Concrete Reservoirs at Miller, W. Va., B. & O. R. R.

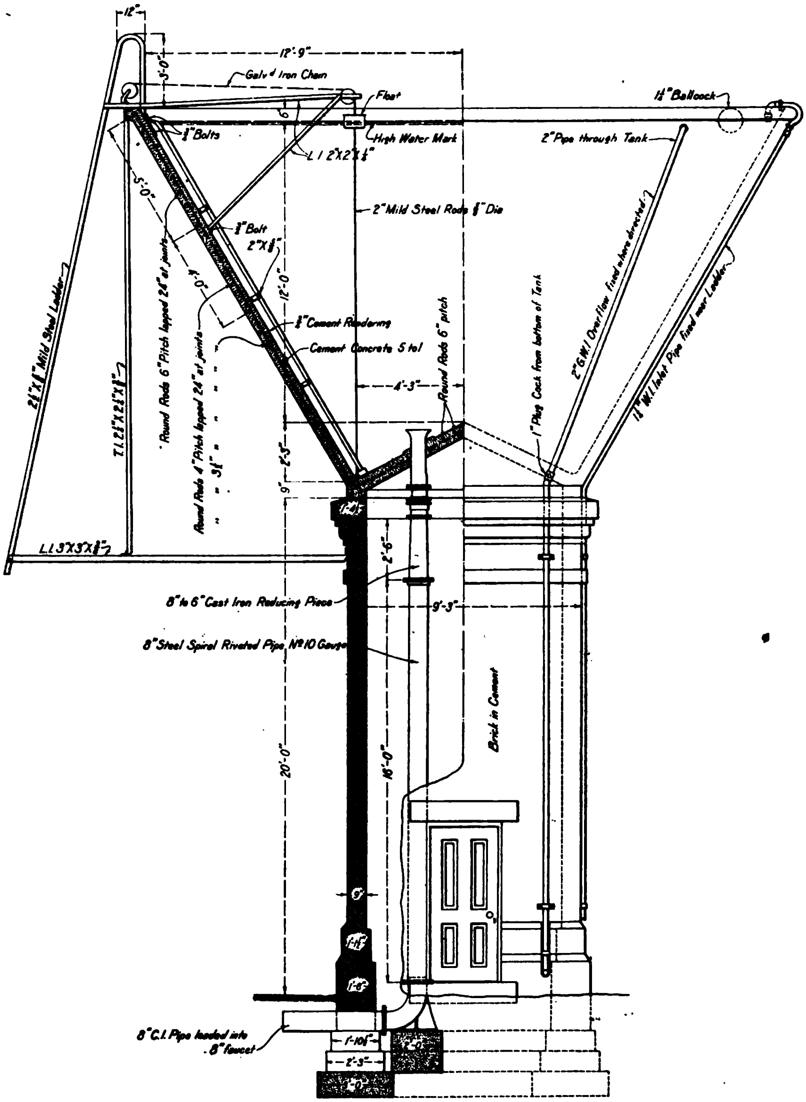


Details Twin Concrete Reservoirs, Miller, W. Va., B. & O. R. R.

These two cuts show Construction Work on Concrete Tank for Victorian Railways.



Reinforced Concrete Tank, Victorian Rys., New South Wales, Australia. Capacity, 25,000 Gallons.



Reinforced Concrete Tank, Victorian Rys., New South Wales, Australia.

removal of the forms, immediately after which they were rubbed down to proper surface. The construction of the second tank was similar to that of the first, the forms and other material being used a second time. All concrete was of 1 : 2 : 4 mixture. Hydrated lime in the proportion of 8 per cent of the volume of Portland cement was used for waterproofing purposes. As far as possible the wall forms were held in position by braces from the outside, the only connection between the outer and inner circle being sufficient wires to hold the spacing strips in position. These wires were cut a short distance beneath the surface of the concrete and the place carefully cemented up before the concrete had dried out, the object being to prevent all metal from showing on the surface.

The arrangement of the reinforcing material is shown on the plan. Where splices in the column occurred the lap was 30 diameters and the rods were secured with No. 12 annealed wire. The horizontal circular rods of the walls were lapped 30 diameters and clamped with Crosby wire rope clips. The vertical rods in the walls were wired to the horizontal rods with No. 12 annealed wire. The bottom was reinforced with No. 38 triangle mesh made by the American Steel & Wire Company.

After the tanks were completed the inside of the walls was given an application of "por-seal." After this had thoroughly dried these surfaces were given a coat of Carey's asphaltic damp-proof paint. These tanks have been filled with water for the past thirty days and while there was some seepage when they were first filled, all pores have now apparently closed up, and at the present time the outer surfaces of the walls are almost perfectly dry.

A distinct departure from the general design is a tank built quite recently by the Victorian Railways in Australia. It is a hollow, inverted, frustrated cone of reinforced concrete resting on a hollow cylinder or tower of brick. This funnel shaped structure has an inside diameter at the top of 25 ft. 6 in. and the water reservoir is 12 ft. deep from the highest part of the floor to the high water mark. The diameter of the water reservoir at the bottom is 8 ft. 6 in. The brick tower has an outside diameter of 9 ft. 3 in. and is 20 ft. high. The total height of the structure above foundation is 35 ft. 6 in.

This funnel shaped tank has a capacity of 20,000 gallons, and while it is an odd looking structure it has the advantage of giving the maximum of water at the maximum head and materially reducing the total weight of the structure. This design is of interest particularly because it shows that it is not necessary to confine ourselves to the old established and well beaten paths. Some photographs and a drawing are reproduced as a part of this report, and the following specifications are interesting.

F. E. Weise,
W. H. Finley,
W. M. Clark,
D. G. Musser,
Committee.

Location	Date	Purpose	Water Reservoir						
			Cap. in Gallons	Dia	Depth	Wall Thickness Bottom	Wall Thickness Top	Floor Thickn's	Roof
Somerset Pa.	1911	Town water-supply water obtained from 3 drilled wells.	500,000	Top 81'-4" Bot 80'-0"	15'-10"	18"	10"	6"	Reinforced concrete 5" thick carried on 10" I-beams supported on 4" W.I. pipe posts
Westerly R.I.	1910	Town water-supply water obtained from driven wells.	660,000	40'-0"	70'-0"	4'-0" at floor tapering to 14" at height of 5'-0"	14"	12"	Gustavino dome of red tile
Norway Mich.	1910	Gravity water-supply for city purpose	300,000.	35'-0"	43'-0"	12"	12"	12"	Concrete dome reinforced with woven wire
Waverly Ohio.	1911	City water-supply	120,000	20'-0"	80'-0"	9"	6"	Foundation forms floor	4" Concrete
Kilbourn Wis.	1911	City water-supply	63,000	30'-0"	9'-0"				Timber and Paroid
Austinburg Ohio	1910	Locomotive supply for Pennsylvania Lines	54,000	24'-0"	16'-0"	8"	6"	8"	Wood
Anaheim Cal	1907	City water-supply	172,000	30'-0"	32'-0"	10"	6"	10"	Concrete
Key West Fla.	1911	Supply for U.S. Naval Station	1,500,000	80'-0"	40'-0"				None
Sir John's Run W.Va.	1911	Locomotive supply for B & O. Ry.	100,000	24'-0"	30'-6"	10"	7"		

Construction Data, Various Tanks and Reservoirs.

Tower or Tank Support	Foundation	Reinforcement	Concrete	
			Proportions and Aggregate	Mixing and Placing
On Ground	Excavation in clay to sandstone formation about 5ft below surface	Walls square twisted steel rods with horiz and vert wired at intersections. Roof-⅜" square twisted rods laid across I-beam stringers, spaced 4" centers, and triangular wire mesh	1:2:4 Lehigh Port. Cement Crushed Rock Sand Sand Rock Ballast	Mixed very wet in continuous mixer. Spaded and worked uniformly in forms.
On Ground	Rests on hard pan 5 or 6ft below surface of ground		Walls 1:1½:3 Vulcanite Port. Cem. Sand containing some Gravel Crushed Granite Cornice 1:2:4 Foundation 1:3:6	
On Ground	Rests on solid rock foundation entirely above ground	45,450 lbs plain round bars Walls-Lower 18ft of 2 circles of 1" and ⅞" rods, above that one circle ⅞" round rods placed vert at 15ft intervals for tie rods Bottom reinforced in two directions Radial bent rods lead from bottom to walls 12" centers	1:1:2 Huron Port Cement Clean, sharp sand obtained nearby. Crushed stone ⅛" to ⅞" in size. Roof 1:2:4	Wet mixture, yet stiff enough so that stone would not settle. Mixing done carefully by hand to insure uniformity
On Ground	22 ft in diam 7ft deep octagon 1 3 4 mixture of concrete wet but not slushey Top of foundation forms floor of tank and finished 1·2·2	⅞" Perpendicular rods spc'd 4ft ⅞" Hor. rods spaced 8 rings at the bottom and 3 rings at the top to the foot 35,000 lbs steel used	1:2:2	Mixture very wet and slushy
On Ground				
Walls same diam as tank	Pile and Concrete		Rich	
Reinforced Con Tower	Concrete 1·3 4½		1 2 2½	Thoroughly mixed and just wet enough to show water on the surface after a thorough tamping
On Ground	Concrete 1 3 6	Vertical Channels horizontal round rods	1:2·4	
Cyl walls same diam as tank	Concrete 1·3·5	Corrugated steel bars	1:2·4 Portland cement Crushed washed glass, Crushed Limestone	

Construction Data, Various Tanks and Reservoirs.

Forms	Finishing and Waterproofing	Cost		Remarks
		Total	Per 1000 Gals	
Wooden	Walls finished with 2 coats of thick Portland Cement wash. Bottom and roof given sidewalk finish.	$5,500.00	$11.00	Excavated material was placed uniformly about completed sidewalls to a grade line 4 ft. below top of walls. Reservoir is reported water-tight
Wood forms for base. Steel forms for all plain wall.	5% Limoid a patented form of hydrated lime. Floor given 1" granolithic finish and inside bevel a plaster coat of the same.	$17,960.00	$27.22	In appearance and water-tightness one of the most successful ever built.
Wood forms used in 3' sections coated with heavy black oil. A coat of parafine oil was applied each time forms were shifted.	Cement mixed with 10% hydrated by volume. Rich mixture used. After completion, inside was given 3 coats of plaster 1 part cement 1½ part sand ¼ part hydrated lime and hydratite	$4,745.00	$15.82	Galvanized iron lining of forms would have given tank a better appearance. Results show that extra expense of cement was fully warranted. Sweating noticed when filled but disappeared after 10 days. Passed a severe winter without any bad effects.
Metal forms in 3 sections.		$4,500.00	$37.50	
		$733.20	$11.64	
Steel Forms		$3,500.00	$64.81	Engineer states that from experience gained he recommends a tank with twice the capacity and with a concrete roof.
		$11,400.00	$66.27	
		$19,950.00	$13.30	
Steel Forms	5% hydrated lime	$7,500.00	$75.00	

Construction Data, Various Tanks and Reservoirs.

APPENDIX.

SPECIFICATIONS FOR REINFORCED TANK AT DANDENONG, VICTORIAN RAILWAYS, NEW SOUTH WALES, AUSTRALIA.

NATURE OF WORKS.—The works comprise the construction and erection of a 20,000 gallon reinforced concrete tank on a brick tower, and the supplying, laying and fixing of cast iron, wrought iron and steel inlet and outlet pipes, ladders, ballcock, etc., at the Dandenong railway station, in strict accordance with the drawings and the annexed conditions of contract and schedule and this specification, and to the satisfaction in every respect of the proper chief officer; also the maintenance of the same as provided for in clause No. 34 of the said conditions of contract.

CARRIAGE OF MATERIALS.—The cast and wrought iron, iron pipes and ironwork for use in connection with this contract will be carried free on the Victorian Railways provided that they be consigned on a departmental consignment note, which on the contractor's application will be furnished to him by the superintending officer, and the contractor will be liable to pay full freight on all such cast and wrought iron, iron pipes and ironwork if not consigned as aforesaid. The contractor shall pay full freight on all materials carried by rail excepting the cast and wrought iron, iron pipes and ironwork as aforesaid.

DRAWINGS.—The drawings referred to in this contract are: No. 1—20,000 gallon reinforced concrete tank, litho. No. 377-09 (amended), and such other drawings as the proper chief officer may from time to time make and supply to the contractor.

INTERFERENCE AND PRECAUTIONS.—The works are to be carried out by the contractor in such a manner as not to interfere with or damage or be the cause of damage to any property or rolling stock or any other thing whatsoever belonging to the corporation, and in such a manner as not to interfere in any way with the traffic or business of the corporation or with any other work or contract that may be in progress on any railway line or premises, and no line of railway or any other portion of the railway premises shall on any account or for any reason or cause whatsoever be obstructed by the contractor without the written permission of the proper chief officer or the superintending officer previously obtained, and the contractor shall provide, maintain, and take all precautions which may be requisite for the convenience and safety of the public and the protection of life and property, or which may be required or ordered by the proper chief officer or the superintending officer.

In the event of the contractor's failure or neglect to carry out the works and provide, maintain, and take all precautions in strict conformity with and with due observance of the provisions herein contained, then in every such case, as often as the same shall occur, the contractor will be held responsible and liable for any loss or damage whatsoever, which in the judgment of the proper chief officer shall have been sustained by the corporation owing to any such failure or neglect by or on the part of the contractor, and the amount of any such loss or damages as assessed by the proper chief officer may from time to time be deducted by the corporation from any money due or which may become due to the contractor

EXCAVATION FOR FOUNDATIONS.

All excavation required in any position or form, whether in earth or rock, shall be taken out to the depths, forms, and dimensions shown, or as the proper chief officer or the superintending officer may direct, and no work

shall be proceeded with on any foundations, etc., until such excavation shall have been approved by some one of such officers. All slopes of cuttings and embankments are to be neatly trimmed to the inclinations shown on the drawing or such other inclinations as the proper chief officer or the superintending officer may direct.

The earth is to be deposited in six-inch lavers and well rammed round all foundations, pipes, etc., and where ordered.

Surplus Earth.—All surplus earth is to be deposited where and trimmed as directed by the proper chief officer or the superintending officer, the lead not to exceed 20 chains.

Side Cuttings.—Should any earth be required for embankments, approaches or footpaths, or for completing any portion of the work, the same shall be taken from side cuttings, which are to be excavated by the contractor in such situations and of whatever forms and extent the proper chief officer or the superintending officer may direct, the lead not to exceed 20 chains.

Where necessary the water shall be properly and effectually pumped out of the cuttings, trenches, etc., and the sides of the same properly shored and planked up. All slips that may occur are to be removed by the contractor at his sole expense, and the foundations must be kept dry until the concrete, etc., is properly set and consolidated.

The rate per cubic yard for excavation for foundations, etc., is to include the cost of depositing the surplus earth where directed, all ramming, trimming, etc., and every appliance necessary for the completion of the work, also all additional expense incurred in repairing slips and damage by floods or any other cause.

Only the Net Quantity Paid For.—Only the net quantity of excavation actually necessary in the judgment of the proper chief officer or the superintending officer for the purpose of receiving foundations, etc., will be paid for, and any excavation in excess of that which is required for such purpose (which the contractor may for his own convenience or safety take out) will not be paid for, but the space caused by such excess excavation shall be filled with approved material rammed in to the satisfaction of the proper chief officer or the superintending officer by the contractor at his own expense.

Cement.—All cement must comply with the "Standard Specifications for Portland Cement for the State of Victoria."

Brickwork.—The bricks are to be machine pressed, specially moulded to suit radius of tower, of approved make, sound, hard and well burnt. The beds and joints are to be full of mortar and the joints are to be neatly struck; no grouting will be allowed; the height of every five courses shall be 16¼ in. All bricks are to be thoroughly wetted before being laid, and shall be laid in approved bond. Spaces are to be left for the inlet and overflow pipes as shown.

Bluestone.—The bluestone is to be perfectly sound, free from honeycomb and all other defects, quarry faced and fine axed in door jambs and in weathering and surface of coping and is to be shaped to the radius of the tower. Spaces are to be left for the inlet and overflow pipes where directed.

Foundations to Tower.

Cement Concrete (6 to 1).—The cement concrete shall consist of one part by measure of Portland cement of quality specified, two parts of clean, sharp, coarse sand, one part of bluestone screenings broken to ¾ in. gauge, and three parts of broken bluestone, broken to 2 in. gauge, all to be mixed in a dry state, then thoroughly incorporated with the proper quantity of water, and used fresh.

The concrete shall be spread in layers of not more than 12 in. thick, and be thoroughly consolidated by ramming. When required, the concrete shall be closely packed round the castings, bolts, plates, etc., and finished in frames, where required, to the forms and dimensions shown by the drawings.

No masonry, brickwork, or ironwork must be commenced upon any concrete foundations until such foundations have been approved by the proper chief officer or the superintending officer.

Reinforced Concrete Tank.

Steel.—The steel rods are to be of the best quality, and of approved brand and make, tough and ductile, well and cleanly rolled to the full section, and free from scales, blisters, laminations, and defects of every sort. They are to have a tensile strength of not less than 27 tons, nor more than 31 tons, with an elongation of at least 20 per cent in a length of 8 in. and must stand being doubled over and bent flat on themselves without fracture. The rods shall present a clean surface to the concrete and be free from mud, dirt and other foreign substances. If the steel has more than a thin film of rust on it, it shall be thoroughly cleaned with wire brushes before being placed in the work.

The steel shall be placed in the forms accurately and secured against disturbances while the concrete is being placed and tamped, and every precaution shall be taken to ensure that the steel occupies exactly the position in the finished work as is shown in the drawing. The rods shall be well tied together at each intersection with No. 16 gauge wire.

Cement Concrete (5 to 1).—The cement concrete shall consist of one part by measure of Portland cement of quality specified, two parts blue stone screenings, all to pass a ¾ in. ring, three parts bluestone toppings to be mixed in a dry state and then thoroughly incorporated with the proper quantity of water and used fresh.

The concrete shall be a good wet mix and deposited in such a manner as not to cause a separation of the mortar from the coarse aggregate. The concrete shall be placed in the forms as soon as possible after mixing, and in no case shall the concrete be used if more than one hour has elapsed since the addition of its water. The concrete shall be deposited in horizontal layers not exceeding 12 in. in height, and thoroughly tamped with tampers of such form as the circumstances require. Before the placing of the concrete is suspended the joint to be formed shall be in such place and shall be made in such manner as the proper chief officer or the superintending officer may direct. Whenever fresh concrete joins the concrete that has set, the old concrete shall be roughed, cleaned and thoroughly slushed with a grout of neat cement and water.

Cement Rendering, Etc.—After the removal of the forms, the inside surface of the tank is to be roughened and cleaned, and the surface grouted with neat cement and rendered with ¾ in. of 2 to 1 cement mortar, composed of one part Portland cement and two parts of clean, sharp, coarse sand. The concrete shell of the tank is to measure 5 in. in thickness after inside rendering. All holes and blemishes on the outside surface are to be neatly pointed up with 1 to 1 cement mortar, and the whole outside surface washed down with a grout of neat cement. No pointing up or finishing the outside surface shall be done until the latter has been inspected by the superintending officer.

Pipes, Bolts, Fittings, Etc.—Provision must be made for building in as the work proceeds all bolts, pipes, ferrules, etc., for fixing the ironwork. Should it be necessary to bore holes in or cut into the finished concrete the authority of the proper chief officer must be obtained before so doing.

Forms.—The forms shall be accurately made and sufficiently substantial to preserve their shape, and shall be thoroughly tied and braced together,

and so supported from the scaffolding that the pressure of the concrete or the movement of the workmen and materials shall not throw them out of place. The forms shall also be sufficiently tight, so as not to permit of any of the concrete leaking out. All to the satisfaction of the proper chief officer or the superintending officer.

Before placing the concrete the insides of all forms shall be thoroughly cleaned of all dirt, chips, nails and rubbish of every description. The surfaces of all forms shall be covered with soft soap, mineral oil, or whitewash to prevent their sticking to the concrete.

The forms for the outside of the tank shall be of tongued and grooved boarding, dressed smooth, and covered with oil paper, canvas or other material, so as to present a smooth and even surface to the concrete. They are to be free from ridges, grain marks or other blemishes. These forms for the inside can be left rough. The forms are to be left in place for at least seven days, and for as much longer time as the proper chief officer or the superintending officer may direct.

Cast Iron.—All castings shall be made to the exact forms and dimensions shown on the drawings, or as approved by the proper chief officer, and all cast iron shall be of the best strong grey iron, clean in the skin, free from blow-holes, honeycomb, or other imperfections or impurities.

Cast Iron Test Bars.—The contractor is to cast, if ordered, with each and every casting of iron for use on the works of this contract at least one test bar, in the presence of the proper chief officer or the superintending officer.

Every such test bar is to be 3 ft. 6 in. long by 2 in. deep by 1 in. broad, and when placed on supports 3 ft. 0 in. apart, shall sustain a load of not less than 26 cwt. at the centre without breaking.

Wrought Iron Pipes.—All wrought iron pipes are to be best galvanized iron pipes, free from all defects, and provided with the necessary flanges, couplings, bends, insertion, etc.

Outlet.—The lower length of the down pipes is to be of No. 10 gauge steel, spiral riveted, 8 in. inside diameter, in one length, with angle iron flanges and insertion joints top and bottom. It is to be bolted to the cast iron footstep bend at the bottom, and to the cast iron reducing piece at the top. The pipe is to be dipped in an approved mixture of tar composition.

The upper length of the downpipe is to be composed of a cast iron reducing piece, a cast iron pipe with funnel-shaped mouth bottom of tank, and an expansion joint with a cast iron gland and stuffing box, a solid drawn brass tube and brass bushes. The whole is to be machined, turned, bored and bolted as shown on detail drawing.

Indicator Gear and Float.—The tank is to be provided with a galvanized wrought iron float working on steel rods fixed to bottom of tank. The indicator is to be fitted with all the necessary angle stays, wheels, brackets, chain, etc., fitted, fixed, and painted as shown.

Inlet Pipe.—The inlet pipe is to be of 3 in. galvanized wrought iron with all the necessary bends, bolts, straps, etc., shown. An approved 3 in. ballcock is also to be provided and fixed. The bend over the top of the tank is to be specially made to conform to the outline of the tank and to be galvanized after bending.

Overflow Pipe.—The overflow pipe is to be of galvanized wrought iron, with all the necessary bends, flanges, couplings, straps, bolts, tubes, etc. The pipe is to be bolted through the wall of the tower and side of tank, and is also to go through the hole made in the stone coping as shown on drawing.

Bolts Through Tank.—Where bolts are shown to go through the side of tank, they are to be enclosed in black iron tubes with flanges, washers and insertion as shown on detail drawing.

LADDERS.—Mild steel ladders are to be provided, fitted and fixed as shown.

DOOR TO TOWER.—The door is to be of Red Deal 2 in. thick, paneled and moulded one side, hung with three approved wrought iron butt hinges to solid Red Deal jambs. The jambs are to be secured with strong wrought iron holdfasts. The door is to be fitted with an approved carpenter's lock and provided with two keys. The whole is to be painted three coats of white lead and oil paint of approved tints.

PAINTING.—The whole of the steel and iron work in pipes, ladders and attachments shall be cleaned free from dirt, rust, etc., and painted one coat of the best red oxide of iron paint before leaving the contractor's yard, and after erection at the site with two coats of best red oxide of iron paint. Parts inaccessible after erection are to be painted before erection.

PATTERNS.—No casting shall be made from any pattern till such pattern has been inspected and approved by the proper chief officer or the superintending officer. All patterns will be provided by the corporation, and on the completion of the contract the whole of such patterns are to be put into proper repair, varnished, repacked, and delivered at the railway station nearest to the place where the castings are manufactured or at the Spencer street railway station yard by and at the sole cost of the contractor.

TESTING AND MAINTENANCE.—Fourteen days after completion the tank will be filled with water, the corporation making the necessary connection to the existing supply, and all the works of this contract will then be thoroughly tested and the whole must be shown to be in perfect working order to the satisfaction of the proper chief officer. The whole of the works are to be maintained in perfect working order in accordance with the provisions of clause 34 of the conditions of contract.

REMOVAL OF REJECTED MATERIALS.—On the completion of the works, the contractor shall remove all rejected pipes and materials from the premises of the corporation, and any such pipes or materials not removed by the contractor within seven days after service upon him of a notice from the proper chief officer or the superintending officer calling upon the contractor so to do may without further notice to the contractor be forfeited and shall without the contractor having any claim to payment in respect thereof become the property of the corporation.

DISCUSSION.

The President:—This is a report that has been continued from last year. If any member wants to discuss concrete tanks we will be glad to hear from him.

Mr. C. E. Smith:—I note a quotation from the engineer who says that the best results in getting water-tight concrete was by using a rather dry mixture. That is so entirely contrary to the experience I have had and the experiences I have read of others having, that it surprises me. Where I wanted concrete to be as nearly water tight as possible it has been my experience that the best results were obtained by using a very wet concrete and a very rich mixture, 1: 1: 2 or 1: 2: 3, rather than a dry mixture. If it is the recommendation, that a dry mixture be used in concrete construction, it is liable to mislead a good many men.

Mr. A. S. Markley:—Another point in work of that kind

where it is important to get a good mixture is that washed gravel or washed sand should be used at all times, eliminating all the clay possible. The least bit of clay in the concrete will spoil the job.

Mr. Reid:—I think concrete tanks should be waterproofed with a waterproofing mixture on the inside. I don't think one can depend entirely on making the concrete itself watertight. It may be made watertight in some cases, but a structure as important as a concrete tank should be thoroughly waterproofed on the inside with a modern method of waterproofing, as we do with our subways and bridge floors.

The President:—Did I understand Mr. Reid to say that in waterproofing he made an extra coating of some kind?

Mr. Reid:—I prefer an extra coating of some kind of waterproofing, some form of asphalt or other method of waterproofing in addition to that already specified of making a wet concrete and making the concrete itself as dense and as nearly impervious to water as possible. I would put the additional waterproofing on the inside.

Mr. Sheldon:—Mr. Smith and Mr. Markley brought out the question of the making of the concrete a very wet mixture. The Atlas Cement Co. has gone to considerable expense in making many experiments with different mixtures of concrete, as to its wetness or dryness. I think they claim, as a result, that a mixture can be too wet. If more water is put into the concrete than will be absorbed by the crystallization of the cement, it goes out and leaves a void. They have published a pamphlet on that particular point. I think that a mixture can be made too wet and it can be too dry to be impervious; there is no question about that.

The President:—Does any other member wish to say anything on this subject? It is very important.

Mr. Long:—In constructing the tanks at Sir John's Run and Chicago Junction, the contractors felt so sure that the concrete could be made water-tight, that they agreed that if we would allow them, they would make the concrete and guarantee it water-tight, but we insisted on their putting a concrete paint on the interior. The tank at Chicago Junction was built last winter. About the time they were finishing it, the thermometer went below zero and the tank was filled perhaps three or four days after it was finished. No water was drawn out for three or

four days, as we did not begin to use the tank as soon as we should have. The water froze and then some engines were sent there to take some of the water so it could be renewed. It was found that it has frozen so thick that, by the time they had taken out the water below the crust of ice and put some more on top, they could not get any water until they broke through this crust. We had a great deal of trouble for several weeks, until we finally ended up with having three thicknesses of ice at different points in the tank. When we finally thawed it out, it pulled out a lot of the concrete with the ice, which naturally allowed the tank to leak at these points. After it was thoroughly dried, we fixed it up and gave it a coat of waterproof paint. After that we had only a slight seepage which has disappeared since. Since that time we have built a tank at M. & K. Junction in West Virginia and guarded against the trouble we had at these other two points. We have here a very successful tank, which has not shown seepage at all. We painted it on the inside with a waterproof paint and rubbed it thoroughly on the outside with waterproof brick. This company used a metal form made for a certain diameter of tank and they fit so tight that they lose very little water. They don't make the mixture so wet that it has more than enough water. I think this gentleman said that a proper amount of water is just sufficient to mix the cement and have it thoroughly absorbed.

Mr. W. M. Clark:—I have never had anything to do with building concrete tanks, but I have been dabbling with concrete for a good many years, though never as an expert, and have used both dry and wet mixtures. There is danger in too dry a mixture. I believe that first class concrete can be made with what is known as a dry mixture, that is, use enough water so that when the concrete is thoroughly rammed, one can bring water to the entire surface. When that is done, it certainly must stand to reason that the concrete is thoroughly wet or else could not draw surplus water to the top. I think that the idea of a wet mixture was first originated to cheapen the labor on concrete, and in a great many cases I believe that we get too much water in. I have had some experiences with concrete repairs in wooden tanks. I have several such tanks that are holding water today, where if it had not been for these concrete patches new tanks would have been required. I have repaired tanks in this manner where the staves were practically rotted out. In one instance

one stave was rotted out for about 18 inches along the side of the stave. This was repaired two years ago, and when I passed it last Friday there was no leak evident. I think that I have either five or six tanks on my division that are repaired in that way.

Mr. J. Dupree:—I would like to ask Mr. Clark how he lines a wooden tank with concrete?

Mr. Clark:—This depends on where the leak is. I have stopped a leak in the bottom by spreading about two inches of very rich concrete over the bottom. If the leak is around the chime, I slope the concrete up to a distance of eight or ten inches, making the concrete probably four or five inches thick where the staves and bottom connect. In the instance where I spoke of the stave being rotted out, I built a form about three feet high to take in about ten inches of concrete and filled that. After it had thoroughly set, I took the form away and have never had any more trouble with it.

Mr. Andrews:—With your permission, I would like to make a few remarks on the subject. Mr. Clark's first experience in this work was with a tank at Lodi, Ohio, in 1902. He had an item on his program, "Rebuild the tank at Lodi," and when we inspected it he said "Now here is something I know you are going to give me, because that tank is liable to fall down before you leave here," and he was backed up by the division engineer. I said "If you will put four inches of concrete in that tank and four additional hoops on the bottom, you will make it stand for a year at least." He did that and continued placing it on his program until 1907 when we felt we had gone far enough and we authorized a new tank at that point. We erected the new tank. The then superintendent thought it was well to leave that tank there for storage; if it fell down, it wouldn't hurt anything, and in 1908, he had that same tank on the budget for a coat of paint.

Mr. Clark:—I want to follow this story up still further. I believe Mr. Andrews allowed the tank to be painted and it made such a good appearance, that, to the best of my information, it is standing there and holding water today.

Mr. Andrews:—That is an absolute fact, and I attribute the safety of that tank entirely to placing the four inches of concrete in the bottom. It was leaking badly and the chimes were bad. By placing the concrete in and putting additional hoops on the tank, it is standing today, ten years after, and it is on the program today for another coat of paint.

Mr. Clark:—The first time that ever I tried putting a concrete bottom in a water tank was in 1898, as an experiment. We had on the Pittsburgh & Western, with which I was connected at that time, a tank that was leaking very badly, and I conceived the idea of trying to fix it up with concrete. We did not think that the cement made in this country was good enough to patch a water tank with, so we got German hydraulic cement to patch the bottom of the tank and made a successful job of it,—so successful that the tank stood and remained in service until it caught fire and burned down.

Mr. Robinson:—Mr. President, I want to ask if the committee secured any prices on the cost of these concrete tanks?

The Secretary:—Costs will be found in the tabulated statements.

Mr. Long:—Those two 100,000 gallon tanks that we built cost in the neighborhood of $7,000 each. The ones at Roseburg and Sir John's Run cost in the neighborhood of $6,400 and the one at Chicago Junction cost about $7,200. I might add, in regard to using the space below the tank for a pump room—on account of the difference in the temperature outside and inside, we found that we had to take the pump out of the basement at Sir John's Run, because of the great amount of condensation that ruined the pump we had there, and we had to renew it.

Subject No. 7

REINFORCED CONCRETE CULVERT PIPE.

REPORT OF COMMITTEE.

While considerable information has been received on this subject, your committee does not feel that it has enough data to enable it to cover the matter fully and offers the following as a progress report, hoping that it may awake a wider interest in the subject and elicit information from other roads using concrete pipe, whose representatives among our membership have not yet been heard from.

The results of our inquiry among the members of the association and some railways not represented in our membership indicate that the use of reinforced concrete pipe is just being taken up, as out of 42 replies received, only 15 give any data in regard to the subject, and several of these indicate only a limited experience with this type of pipe. All using pipe of this description, however, are impressed with its economy and report favorably regarding it so that it promises to come into much larger use as a substitute for cast iron pipe.

Information has been received from representatives of the following roads using reinforced concrete culvert pipe:—Ark. S. E.; A. T. & S. F.; B. & O.; C. & N. W.; Cent. New Eng.; C. M. & St. P.; D. L. & W.; Erie; E. J. & E.; I. C.; P. R. R.; S. P.; and Wabash.

We understand the following roads also make use of concrete culvert pipe: C. B. & Q.; Soo; G. N.; N. P.; M. & St. L.; C. G. W.; C. R. I. & P.; C. & E. I.; K. C. S.; Q. & C.; Big Four; M. C.; L. S. & M. S.; C. P. R.; Grand Trunk; and M. & O.; we trust that their representatives will be heard from during the discussion of this subject in the convention.

Table A gives a synopsis of replies received from those who have used this kind of a culvert pipe.

In appendix A will be found extracts from some of the replies received from the committee's circular letter with plans and specifications furnished in some instances.

Fitness for Use in Embankments.

Several roads are already adopting this form of construction for standard culverts under fills of all heights. There is no difficulty in designing reinforced concrete pipe to meet all conditions of loading, to secure sections with diameters up to 48 in. whose weight will permit handling by the same methods by which cast iron pipe is placed. Several miles of such pipe are being laid on the C. M. & St. P., this summer in connection with double track and change of line. Concrete pipe is used instead of cast iron as far as the available supply permits, except in the extension of existing culverts or at points where the thinner cast iron pipe is more convenient, as in replacing a timber box culvert.

Possibly, in mountainous country where pipe would be laid on steep grades, the attrition of sand bearing water at high velocities might cause trouble with this class of pipe, by gradually scouring away the invert and exposing the reinforcing. Where timber trestles are being filled and the drainage area is such as can be cared for by a pipe, generally the most

TABLE A.

ROAD	CONDITIONS OF USE	KIND OF PIPE	INSIDE DIAMETER	THICKNESS
1. ARKANSAS S.E.	UNDER CONSIDERATION		18"	3"
2. A.T.&S.F.	SAME AS CAST IRON	MFR'S DESIGN	12" TO 72"	2" TO 7"
3. B.&O.	SAME AS CAST IRON	CIRCULAR, RAILWAY CO'S DESIGN	24"-36"-48"	4"-5"-6"
4. C.&N-W.	AVERAGE CONDITIONS	ELLIPTICAL SECTION	24"-36"-48"	$2\frac{3}{4}$"-$3\frac{3}{4}$" $4\frac{1}{4}$"
5. CENT. NEW ENG.	WHEREVER IRON PIPE IS USED	ELLIPTICAL SECTION	24"-36"	4"-4"
6. C.M.&ST.P.	WHEREVER IRON PIPE WOULD BE USED AND CONDITIONS PERMIT	CIRCULAR SECTION	24"-30" 36"-48"	$4\frac{1}{2}$"-$5\frac{1}{2}$" $4\frac{1}{2}$"-$5\frac{1}{2}$"
7. D.L.&W.	UNDER ALL CONDITIONS EXCEPT WERE MINE WATER IS PRESENT.	CIRCULAR	24"-30"-36"	4"-4"-$4\frac{1}{2}$"
8. ERIE	UNDER ROADBED	CIRCULAR	20"-24" 30"-36"	$2\frac{1}{2}$"-4" 4"-4"
9. E.J.&E.	STANDARD FOR ALL PIPE CULVERTS IN PLACE OF CAST IRON UP TO 48" IN DIAMETER.	CIRCULAR SECTION	24"-30"-36" 42"-48"	5" FOR 24" 6" " 36" 6" " 48"
10. I.C.	AVERAGE CONDITIONS	CIRCULAR SECTION	36"-48"-60"	4" ALL SIZES
11. N.Y.W.&B.	LIMITED AMOUNT	ELLIPTICAL SECTION	48"	4"
12. PENNA.	SMALL AMOUNTS EXPERIMENTALLY	AM. CONC. PILE AND PIPE CO. CIRCULAR SECTION		
13. S.P.	ANYWHERE WITH MORE THAN 3' BETWEEN PIPE AND BASE OF RAIL.	PLAIN CONCRETE NOT REINFORCED	12"-18"-24" 30"-36"	2"-3"-4" 5"-6"
14. WABASH	WHEREVER IRON PIPE CAN BE USED	CIRCULAR RY. CO'S. DESIGN	24" TO 48"	4" ALL SIZES

Details Concrete Culvert Pipe, Various Railroads.

TABLE A.

	LENGTH	JOINT	WEIGHT IN LBS.	COST OF LAYING	PIPE MADE BY RY. CO. OR BOUGHT	PLANS & SPECIFICATIONS	AGE PIPE HANDLED
1.	3′	BUTT	660 PER SECT.	$1.50 PER SECT.	RY. CO.		7 DAYS
2.	3′	SPL.			BOUGHT	MFR'S. SPECFNS.	4 TO 6 WEEKS
3.	4′	BUTT JOINTS		$2.00 FOR 36″	RY. CO.	PLANS	3 TO 4 WEEKS
4.	8′	BELL		$1.45 PER FT. 2.05 " " 3.42 " "	MF'D BY CONTRACT, RY. FURNISHING MAT'L.	MFR'S DESIGN & CO'S. SPEC.	
5.	8′	BELL		SAME AS CAST IRON	BOUGHT	MFR'S DESIGN	4 TO 6 WEEKS
6.	6′	BEVELLED SHOULDER	2400 FOR 24″ 3750 " 30″ 3725 " 36″ 5770 " 48″	DOES NOT VARY MUCH FROM CAST IRON.	RY. CO. SOME BOUGHT	RY. CO. DESIGN	20 DAYS IN SUMMER. 30 DAYS IN WINTER
7.	24″-10′ 30″-8′ 36″-6′	BELL		SAME AS CAST IRON	RY. CO.		7 TO 28 DAYS SHOULD NOT BE LESS THAN 2 WEEKS
8.	6′	BELL	219 PER. FT. 405 " " 490 " " 584 " "		BOUGHT	NONE	AS SOON AS DEL'D FROM FACTORY
9.	8′	BELL	24″-350 PER FT. 36″-525 " " 48″-700 " "		BOUGHT	MFR'S DESIGN	30 DAYS
10.	6′-4″ FOR 36″ & 48″ 5′-4″ FOR 60″	BELL			RY. CO.	RY. CO'S. DESIGN	
11.	8′	BELL	3 TONS PER SECTION	$1.50	BOUGHT	MFR'S. DESIGN & SPEC.	30 DAYS
12.					BOUGHT		
13.	3′	BELL & SPIGOT & ALSO BEVEL	100 200 350 530 780	SAME AS CAST IRON	RY. CO.	NONE	30 DAYS
14.	4′-8′	BELL	24″-56 PER FT. 36″-78 " " 48″-100 " "	$1.00 TO $2.00 PER FT.	RY. CO. AND ALSO BOUGHT	BLUEPRINTS FURNISHED	30 DAYS

Details Concrete Culvert Pipe, Various Railroads.

TABLE A.

	DEFECTS DUE TO FROST OR IMPURE WATER	JOINTS CEMENTED	TIME IN SERVICE	RELATIVE ECONOMY WITH CAST IRON PIPE.	GENERAL EXPERIENCE
1.	NONE	YES	5 YEARS	UNDER CONDITIONS OF HAUL AND BUILT AT SITE 1/10 THAT OF CAST IRON.	SATISFACTORY FOR THE SIZE MADE
2.		YES	2 YEARS		SATISFACTORY
3.	NONE	YES	3 YEARS	50% CHEAPER	SATISFACTORY
4.				25% CHEAPER	
5.	NONE	YES	3 YEARS	CHEAPER IN FIRST COST & INSTALLATION	VERY SATISFACTORY
6.	NONE	NO	1½ YEARS	30% TO 50% CHEAPER	SATISFACTORY SO FAR
7.	NONE MINE WATER WILL CAUSE DISINTEGRATION	NO EXCEPT SPECIAL CASES	3 YEARS	CHEAPER THAN CAST IRON ABOVE 18", MORE ECONOMY AS THE DIAMETR OF PIPE INCREASES.	SATISFACTORY SO FAR
8.	NONE	YES	9 MOS.		LIMITED EXPERIENCE, SATISFACTORY SO FAR
9.	NONE	YES	1 YEAR	25% TO 40% CHEAPER	SATISFACTORY SO FAR
10.	NONE	NO	3 YEARS	50% CHEAPER	
11.	NONE	NO	1 YEAR	25% SAVING	FAVORABLE
12.			ONLY TRIED THIS YEAR	25% TO 50% CHEAPER	ONLY SMALL AMOUNTS BOUGHT THIS SEASON FOR EXPERIMENTAL USE.
13.	NONE	YES	10 YEARS	12"- 40¢ 18"- 50¢ 24"- 70¢ 36"- $1.25	SATISFACTORY
14.	NONE	NO	5 YEARS	50% SAVING	SATISFACTORY

Details Concrete Culvert Pipe, Various Railroads.

economical opening to provide is a reinforced concrete pipe up to a diameter of 48 in. For openings larger than this some form of culvert built in place will be cheaper. The question of available material and length of haul will, of course, influence the type of opening used; however, an investigation showed that on the C. M. & St. P., even with carload tariff rates, a haul of 570 miles could be incurred and still make it economical to use the concrete pipe rather than cast iron. Aside from questions of cost, a properly reinforced pipe will be more apt to fail gradually in the event of breaking under the fill than will cast iron pipe. So far, however, no failures have been reported.

Types of Pipe.

There is considerable variety in the types of pipe used and in the general dimensions and manner of reinforcing.

For convenience in handling, the six foot section adopted by the C. M. & St. P. proves a desirable length and provides units of ready adaptation to varying heights of fill. Sections of this length up to 48 in. in dia. are readily unloaded from cars without special appliances. The thickness of the pipe depends on the character and disposition of the reinforcement. In one type of patented pipe the reinforcement is disposed of so as to be situated in the region of tension throughout, the section being elliptical. Pipe of this kind must be placed with its major axis vertical and while permitting the use of thinner walls, it is not as convenient to handle as circular pipe which does not require a special position in service.

Recent experience of the C. R. I. & P., in using the longer 8 ft. sections on new line construction involving considerable team haul and transfer of pipe would indicate that shorter lengths are preferable. On new line work on the C. M. & St. P. their standard pipe was found much more convenient than the bell jointed pipe of longer section bought outside; and it was found much more costly to place the oval pipes than cylindrical ones; especial difficulty being experienced in rolling the former into place over rough and wet ground.

Joints.

Most users of concrete pipe seem to adhere to the bell and spigot joints similar to those employed with cast iron pipe. One form of the joint used is a modification of the bell and spigot, the bell having the same external diameter as the balance of the section and the wall of the spigot end being tapered, with a band locking the reinforcing of adjacent sections together, the recess occupied by the band being afterwards filled with mortar.

A pipe designed by Messrs. Graham and Andrews of the B. & O., has three pockets recessed on the outside of the pipe which permit the wiring of anchors in adjacent sections together, the pockets afterwards being filled with mortar.

In the C. M. & St. P. standard pipe the ends are bevelled, with the portions adjacent to the outer and inner circumferences square. This results in a pipe with exterior and interior surfaces flush throughout its length when laid, insures an even bedding and greatly simplifies the forms required, as it reduces them to plane cylindrical surfaces, the bevels being formed by cast iron rings which serve to space the interior and exterior forms. A pipe having a uniform external diameter is much easier to handle and unload from cars and can be quickly rolled off while those having enlarged bells usually are loaded vertically, bell down, and are very cumbersome to unload on a main line without special equipment.

Reinforcing.

For the smaller sizes of pipe, some form of woven wire fabric seems to be used mostly with built up cages of light bars for the larger sections; a study of the plans submitted will best indicate the practice followed. For economy in handling, some form of reinforcing that will build up a stiff cage that can be handled and set in the forms without collapsing is desirable. In building the cables for the C. M. & St. P. type, experience showed that by wiring alternate hoops to the longitudinal reinforcement in opposite directions a stiff cage resulted, while if wired in the same direction, it readily collapsed when laid on its side. The specifications do not differ materially from those required in any other highly reinforced concrete construction, a 1: 2: 4 mixture with stone of 1 in. maximum diameter prevailing.

Seasoning, etc.

A period of 30 days for curing before putting pipe in service seems desirable though in summer this may be reduced to 20 days. One manufacturer writes that he had trouble with pipe which were shipped when 10 days old due to the development of fine hair cracks and that they now would not permit their pipe to be shipped out until a month old.

Pipe can be unloaded by skidding from cars with snub lines and can be rolled down embankments with less danger of breakage than cast iron pipe. In some instances, pipe are simply dropped off the cars and allowed to roll down the banks. Methods in general are the same as those used for unloading cast iron pipe though some roads use derricks to handle the larger sizes.

Practice varies regarding filling the joints, some cementing them and others simply depending on the fit of the sections. It does not appear necessary under ordinary conditions.

Little information was received in regard to the type of forms used except that steel forms were considered superior to those of wood. On the C. M. & St. P., wooden forms were used when the manufacture was first started but these are being discarded as they wear out, and are replaced by steel forms of the company's own design, and which are proving very satisfactory. About one year's steady service was found to be all that could be gotten out of wooden forms and the steel forms are much more economical.

Economy.

There is practical unanimity regarding the saving effected by the use of concrete pipe in place of cast iron, the relative cost depending on local conditions, but being from 25 to 50 per cent less. The economy is more marked with increase in diameter.

With cast iron at $28.00 per ton, and the market quotations for manufactured concrete pipe, the following shows the relative costs per lin. ft., for the two kinds:

	24 in.	30 in.	35 in.	48 in.
Cast Iron	$2.23	$3.33	$4.66	$8.26
Concrete	2.00	2.80	3.15	4.50

Very few railways have had concrete pipe in use many years. The Wabash have had pipe in service for five years and no failures have been observed, here or elsewhere where the pipe have been properly handled and placed.

L. D. Hadwen,
H. H. Decker,
R. O. Elliot,
F. O. Draper,
F. E. King,
G. Loughnane,
Committee.

APPENDIX A.

EXTRACTS FROM LETTERS RECEIVED IN RESPONSE TO LETTER OF INQUIRY.

A. M. Van Auken, chief engineer, Arkansas Southeastern:—We had a piece of construction where we desired to put in something more permanent than wood boxes and we used reinforced concrete pipe solely because of cost. The freight charges made cast iron and vitrified pipe unduly expensive on that job.

Below are the estimated costs per lin. ft.:

Size	Cast Iron	Vitrified	Reinforced Concrete
12 in.	$2.44	$ .30	$ .24
18 in.	5.43	.69	.50
24 in.	8.13	1.41	1.04
30 in.	10.86	2.04	1.32
36 in.	14.63	3.41	1.65
42 in.	19.50		2.30
48 in.	23.56		2.75

On this work sand and gravel were of easy access, while cost of hauling was rather excessive.

J. F. Parker, general foreman, A. T. & S. F.:—We have been using reinforced concrete pipe for about two years for culvert work. The cost of laying per lineal foot varies a great deal according to the conditions. For instance, if the pipe is to be placed in a fill 10 or 12 ft. high, the largest expense would be in excavating and back filling. We build concrete end walls for this pipe, costing according to the number of yards of concrete in the wall and the size of the pipe. We handle the pipe by hand, lowering it off the car by means of ropes so as to let it down the bank easily. A pipe should not be placed under a fill until it has reached the age of from four to six weeks. It is our practice to fill joints. We have been using this pipe about two years and have not had any failures. The cost of the pipe is as follows:

12 in pipe	$ .65 per ft.
48 in. pipe	3.25 per ft.

The intervening sizes cost in the same proportion.

G. W. Andrews, inspector of maintenance, B. & O.:—Instead of using the form as designed by us we are arranging to use the forms as made by the Blaw Centering Company of Pittsburgh, Pa. No particular advantages are claimed for this pipe over that of the bell end concrete pipe, other than there is larger space at the joints to take care of pulling than there is in bell end pipe. We have made quite a lot of pipe of 36 in. diameter at a cost of $2 per lineal foot, which is approximately about one-third the cost of cast iron pipe and probably one-third less than the price paid manufacturers for concrete pipe.

G. W. Hand, assistant engineer, C. & N. W.:—This company uses reinforced concrete culvert pipe under average conditions. The pipe is made under the following specifications:

Concrete.

1 part Portland cement, 1½ parts torpedo sand, 1½ parts gravel or crushed stone passing ¾ in. ring. Tensile strength of concrete, after seven days in water, to be 175 lbs. per sq. in. at 70 deg. F.

Reinforcement.

24 Inch Pipe:—No. 23 triangular mesh bent to circular form and adequately wired at splice with 6 in. lap. Longitudinal reinforcement to consist of 12 three-eighths in. bars spaced equidistant center to center and bent to extend into the bell and within 2 in. of the surface of the end.

36 Inch Pipe:—Transverse reinforcement consists of ⅜ in. corrugated bars spaced 4 in. center to center. These bars are bent to a circle and a splice made by lapping the ends 9 in. and wiring. Joints to be at quarter points. Longitudinal reinforcement consists of bars of the same size bent to extend into the bell, 12 in. bars being used. The bell is reinforced with two bars of the same size spaced 3 in. apart.

48 Inch Pipe:—Transverse reinforcement consists of ½ in. corrugated bars spaced 4 in. apart. Longitudinal bars of the same size, 16 being used. The bells are reinforced with two ½ in. bars spaced 3 in. apart. All laps in annular rings to be staggered.

The total cost of these pipes is as follows:

Size	Material	Manufacturing	Placing	Total
24 in.	$ .40	$1.70	$1.45	$3.55
36 in.	.62	2.60	2.05	5.27
48 in.	.86	3.85	3.42	8.13

This indicates that the cost of the pipe varies from 70 per cent in the case of 24 in. to 50 per cent in the case of the 48 in. size of the cost of cast iron pipe at $26 per ton. The cost of placing is greater than the cost of placing cast iron pipe. The loss from breakage is greater, but on the whole reinforced concrete pipe shows a saving over cast iron pipe of about 25 per cent in first cost. The question of durability has not been determined.

A. Montzheimer, chief engineer, E. J. & E.:—The E. J. & E. has adopted the use of reinforced concrete pipe for culverts in place of cast iron pipe for all openings where they will not be greater than 48 in. in diameter.

The diameters inside and outside are as follows:

Inside Diameter	Outside Diameter
24 in.	34 in.
36 in.	48 in.
48 in.	60 in.

The sections are eight feet long with bell and spigot.
The 24 in. diam. weighs 2,800 lbs., or 350 lbs. per ft.
The 36 in. diam. weighs 4,200 lbs., or 525 lbs. per ft.
The 48 in. diam. weighs 5,600 lbs., or 700 lbs. per ft.

On account of the weight of concrete pipe we have found it necessary to handle it with a derrick and work train. We have a 10-ton steam derrick in the bridge and building department that is used for this purpose. With cast iron pipe no work train service is required, as the pipe can be rolled from a flat car without danger of breaking and all sizes can be handled with a hand winch and tackle.

We have had concrete pipe in service for about one year without failure of any kind.

I quote the following note from W. B. Hotson, chief draftsman, under date of December 14, 1910:

"I find that for both the 36 in. and 48 in. pipe the medium weight cast iron pipe is the stronger, the 36 in. cast iron pipe being 1¾ times as strong as the 36 in. reinforced concrete pipe, and the 48 in. medium weight cast iron pipe about 1½ times as strong as the 48 in. reinforced concrete pipe. On the prints of the 24 in. reinforced concrete pipe there is not sufficient data for figuring its strength in that the amount of steel used is not shown."

F. O. Draper, superintendent of bridges, Illinois Central:—We have been using concrete pipe for the past three years with the very best results. I do

not think that we have had but one culvert that has caused any trouble. This was on a very heavy fill and was filled by plowing off the cars, the material dropping a distance of about 30 ft. We had one pipe which crushed; this proved, however, to be a defective pipe.

Before starting to use these pipes we had a test made at the University of Illinois of the strength of the concrete pipe, also of the cast iron pipe of the same size, 48 in. in diameter. The test was made by putting the joint of pipe into sand and tamping it thoroughly over the pipe, and by using hydraulic pressure for loading. The concrete pipe broke at 260,000 lbs. and the cast iron pipe, placed in the same manner, broke at 240,000 lbs. After the concrete pipe was broken it took the same load that it took to break the cast iron pipe, 240,000 lbs., before it went to pieces, which shows a considerable difference in strength between the two classes of material.

I believe that the concrete pipe is stronger and more durable and is about 50 per cent cheaper than the cast iron pipe. Of course, concrete pipe is more difficult to handle than cast iron pipe. In handling concrete pipe it is necessary in most cases to unload them with derrick cars and place them as near as possible in their final position with this equipment, as it is not practicable to roll them off cars the same as one would roll off cast iron pipe. I would not recommend installing this class of culverts smaller than 30 in., or larger than 60 in. In sizes below 30 in. it would be better and cheaper to use cast iron, and above 60 in. it is better to build a different style of structure.

E. Langford, acting chief engineer, New York, Westchester & Boston:—This company has used 1,800 ft. of concrete pipe with a diameter of 48 in. inside, and 56 in. outside, and a length of section of eight feet. The pipe had bell joints and weighed three tons per section. The cost of placing in the open trench was $1.50 per lineal foot. The pipe have been in service for 12 months and no failures have been observed. It shows a saving of about 25 per cent over cast iron pipe.

G. W. Rear, general bridge inspector, Sou. Pac. Co.:—We use non-reinforced concrete culvert pipe under all conditions where it is large enough to carry the water excepting that the pipe must be at least three ft. below the top of the tie.

We use pipe of the following sizes:

Inside Diameter	Outside Diameter
12 in.	16 in.
12 in.	24 in. special for drainage close up to rail.
18 in.	24 in.
24 in.	32 in.
30 in.	40 in.
36 in.	48 in.

The sections are 36 in. long. A modified bell and spigot are used and where the thickness of the wall is sufficient the bell is formed in the wall itself Where the wall is thinner it is flared out.

The approximate weight per 3 ft. lengths is as follows:

12 in.	300 lbs.
12 in. special	1,000 lbs.
18 in.	600 lbs.
24 in.	1,050 lbs.
30 in.	1,650 lbs.
36 in.	2,350 lbs.

The actual cost of handling and placing is a very small part of the job and is very little greater than for cast iron.

Concrete pipe costs us as follows, compared with the cost of cast iron pipe in the market:

Size	Concrete	Cast Iron
12 in.	$ .40 ft.	$1.80 ft.
18 in.	.50 ft.	2.80 ft.
24 in.	.70 ft.	4.00 ft.
36 in.	1.25 ft.	9.00 ft.

The cost of handling is not much greater than with cast iron. There is a little more excavation in a fill on account of the outside diameter of the pipe being larger and the pipe has to be handled a little more carefully. We have hundreds of these pipe culverts in all kinds of climate and they are very satisfactory.

W. T. Powell, superintendent of bridges and buildings, Colorado & Southern:—We have used a great deal of concrete pipe built in one piece on the ground and reinforced with woven fence wire. The cost is about as follows, including head walls, excavation and all material:

36 in. diam. 8 in. thick................	$5.00 lin. ft.
42 in. diam. 8 in. thick................	5.50 lin. ft.
48 in. diam. 8 in. thick................	6.50 lin. ft.

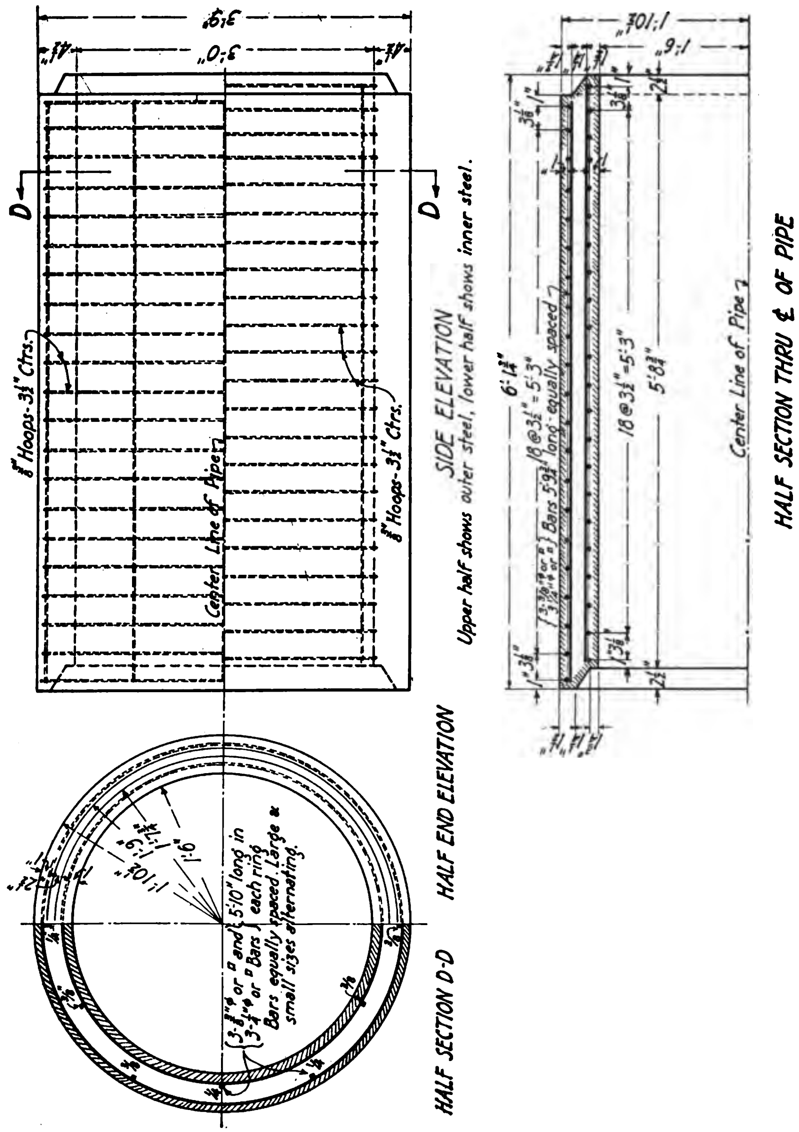
Oscar I. West, manager, American Concrete Pile & Pipe Co.:—We recommend that the pipes be loaded in such a way as to enable the section men to roll them from the cars, our belief being that pipes properly made and cured may be handled with much less danger of breakage than cast iron, simply by the use of skids and a snub line. We have had a standing offer to replace any pipes free of charge which have been broken in handling. and we have never been called upon to replace any except in the case of where some pipes were shipped which were not properly cured.

It has come to our attention frequently that pipes are pushed from the sides of the car and allowed to roll down the bank without the use of any skids whatever, and so far as we know, with no injurious effect to the pipe. We have standing instructions with all our foremen not to ship pipes until they have had at least one month seasoning. In the summer of 1911 under stress of urgent appeals from railways to furnish them pipe, we permitted some to go out which had been cured but ten days. These pipes were sent out from three different plants to three different railways and the experience was the same in each case, namely, that the concrete appeared to be filled with fine hair cracks so that as soon as the pipe were put under a load they broke. We did not ship very many of them before discovering this and on giving them the proper time to season we had no further difficulty.

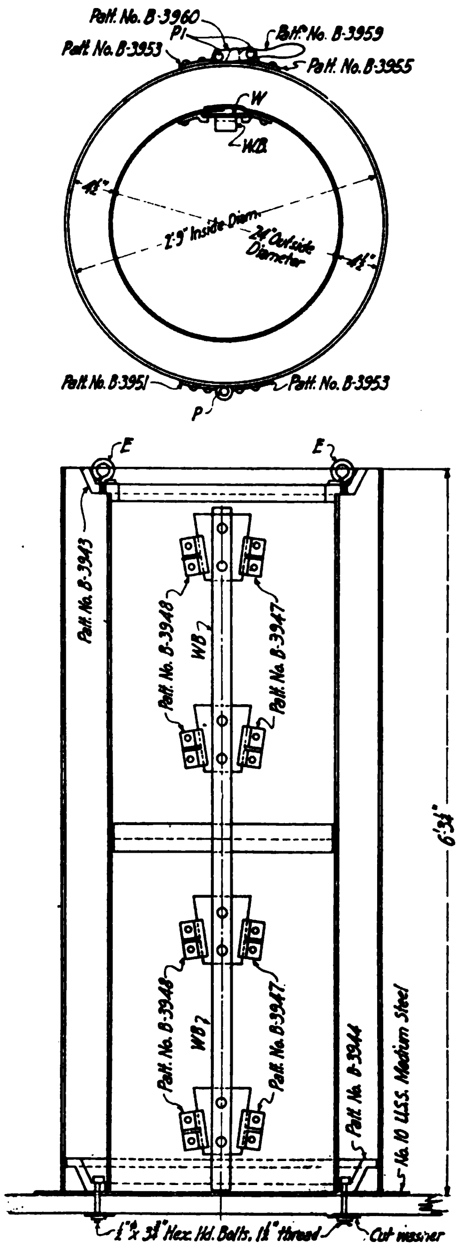
C. H. Cartlidge, C. B. & Q. R. R.:—We use reinforced concrete culvert pipe under all conditions where pipe is used. We buy some pipe, as well as manufacturing some of it ourselves. The methods of handling and placing concrete pipe are similar to those for cast iron pipe. Concrete pipe is handled and placed under fill after 30 days old.

We have not experienced any defects due to frost or the action of impure water. The joints are filled in some cases, especially where we expect the pipe to work under a head. Some of this pipe has been in service six years with no failures whatever. This company can show a saving of about $400,000 in six years over what cast iron pipe would have cost, prices taken yearly at the market rate.

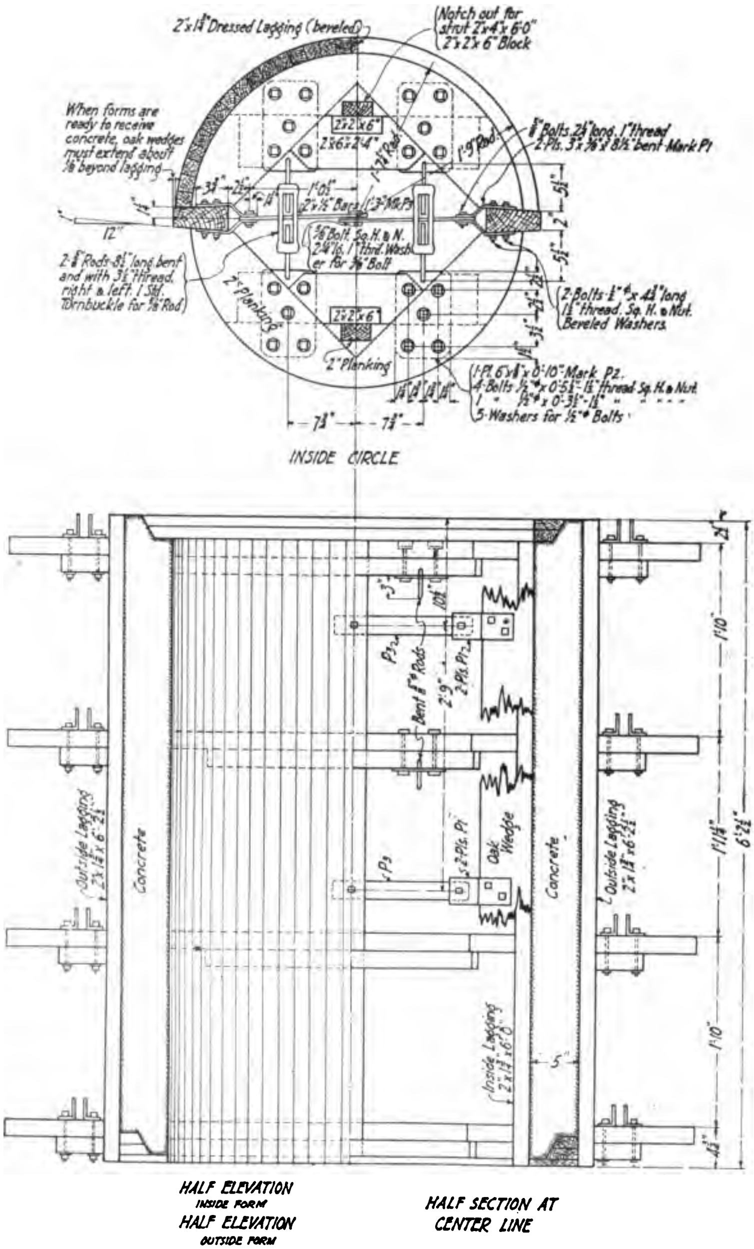
We are constantly increasing our output of reinforced concrete culvert pipe and expect to build about 200,000 lineal feet within the next six or seven years. Our sizes run from two feet to six feet in diameter; sketch showing reinforcement is shown on page 105.



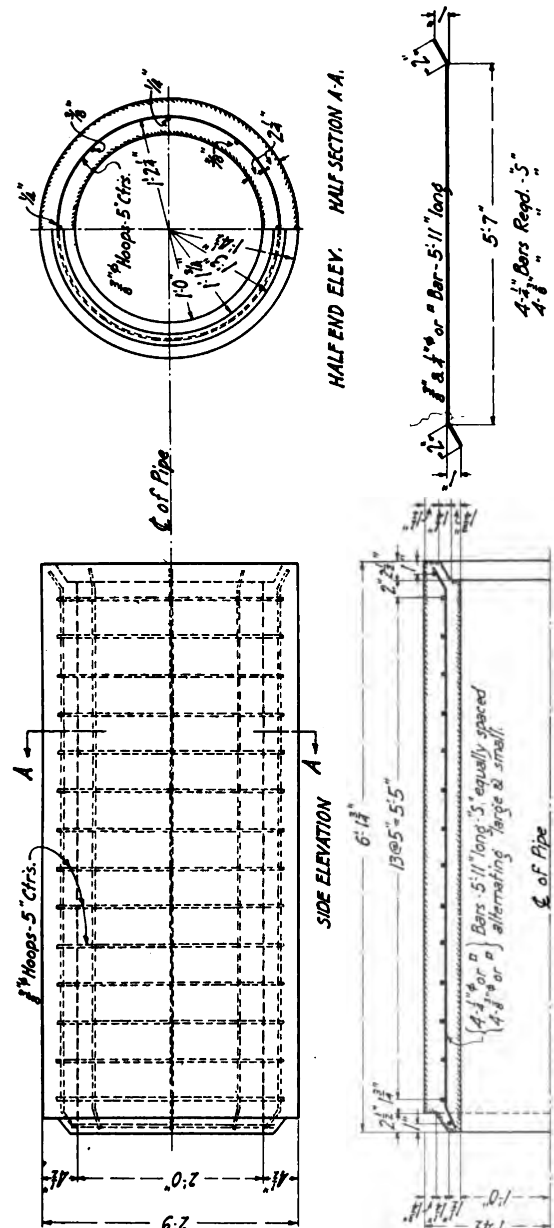
Heavy Reinforced Concrete Culvert Pipe, 36 in. Diam., C. M. & St. P. Ry.



Steel Form for 24-inch Concrete Culvert Pipe, C. M. & St. P. Ry.



Wooden Form for 42-inch Concrete Culvert Pipe, C. M. & St. P. Ry.



Heavy Concrete Culvert Pipe, 24-inch, C. M. & St. P. Ry.

APPENDIX B.

THE CONSTRUCTION OF CONCRETE PIPE BY THE C. M. & ST. P. AT TOMAH, WIS.

F. E. King, assistant engineer, C. M. & St. P. Ry.:—The question of making concrete pipe had been under consideration for some time but no definite move was made until July, 1911, when an experimental plant was started in Tomah, Wis. At first the plant was equipped with only two forms. These forms were of steel construction; one of them for 24 in. and the otner for 30 in. pipe. Later on three 24 in., three 30 in. and six 36 in. additional wooden forms were provided.

As the pipe are built in a vertical position, they rest on the form that moulds the spigot end of the pipe. It was therefore necessary to furnish about three times as many bottom plates as forms. These additional end forms were for the most part constructed of wood. One cast iron bottom plate and one cast iron top plate were however furnished with each of the steel forms. The construction of these forms is shown in the accompanying figures. Forms for other sizes are of similar construction. The wooden forms were lined with sheet steel of about 22 to 24 gauge, although this is not indicated in the drawing.

Other equipment consisted of a Smith concrete mixer, and a locomotive crane which handled the forms, removed the pipe from the working platform and took them to the stock piles. This however required only a short time in the early part of the day and the crane was engaged on other work around the yard having no connection whatever with the pipe plant the balance of the time. The arrangement of this temporary plant is shown in the plan reproduced herewith. The installation of this plant was begun July 12, 1911, and it was operated continuously until December 23, 1911. Provisions were made for housing the green pipe and keeping them warm while the weather was not too severe, but it was not thought advisable to carry on operations during the winter.

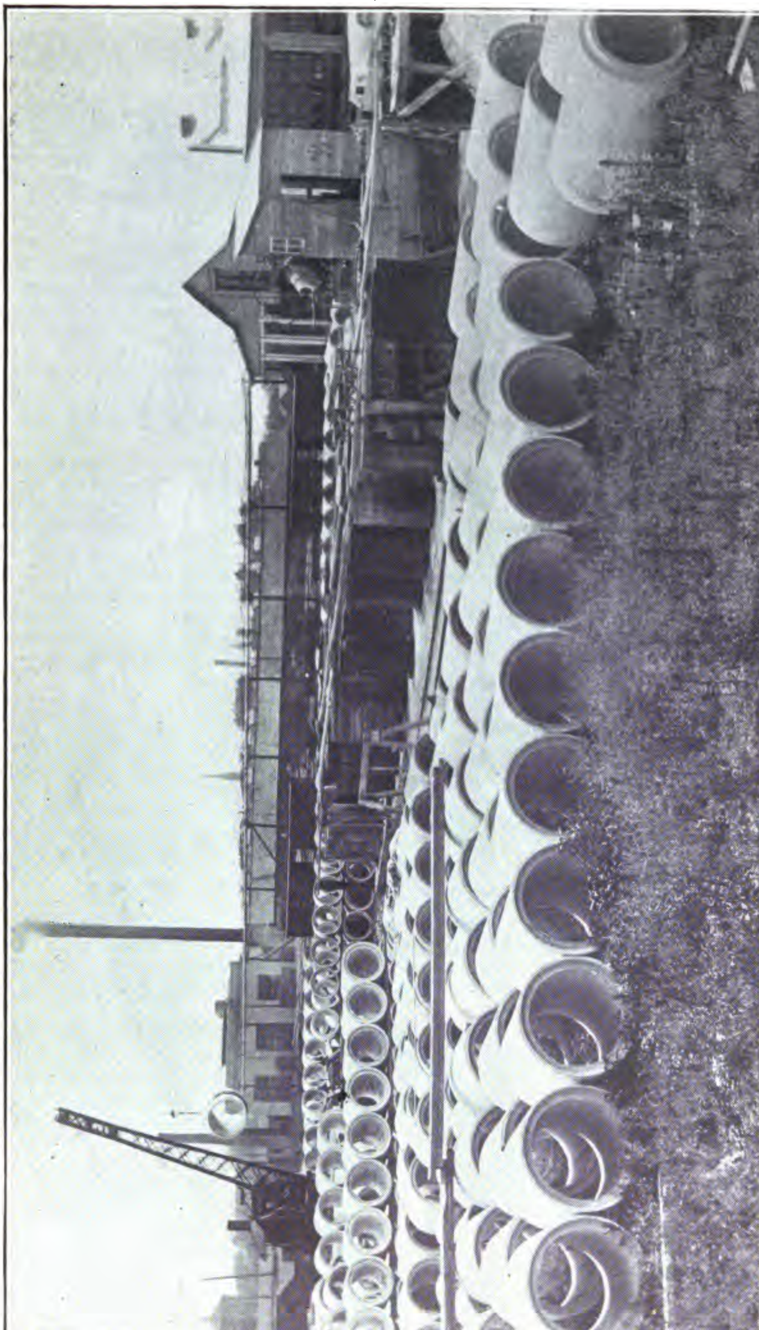
The pipe are circular in section with an effective length of six ft. The over-all length is six ft. 2½ in., the 2½ in. being used for the joint. The 24 in. pipe has a thickness of wall of 4½ in. and contains a single course of reinforcing in the center of the wall. The 30 in. pipe have walls 5½ in. in thickness with a single course of reinforcing in the center of the wall. The 36 in. pipe is 4½ in. in thickness with a double course of reinforcing. The 48 in. pipe are similar to the 36 in. pipe, except that the walls are 5½ in. in thickness. No 42 in. and 48 in. pipe were built during 1911. In 1912 however some forms for these sizes were furnished and pipe made, or will be made before the season closes.

The concrete mixture in all cases consisted of one part of cement, two parts of sand and 4 parts of crushed rock. The rock used consists of all the particles held on a screen with ¼ in. openings that will pass a screen with one in. openings. The reinforcing employed during 1911 consisted of ⅜ in. round deformed bars.

The output of the pipe plant for 1911 consisted of 327-24 in. pipe; 352-30 in. and 260-36 in. pipe; a total of 939 pieces of all sizes. The total yardage of concrete used in these pipe amounted to 770 cu. yds., the sacks of cement used 5,360; crushed rock, 632 cu. yds.; sand, 379 cu. yds. and gravel 106 cubic yards. The average number of sacks of cement per cu. yd. of concrete was 7.04 and the total pounds of reinforcing metal 111,845.

The force of men employed consisted of a foreman and seven men in July and was gradually increased from that number to a foreman and 17 men in December.

The work of preparing the plant for operation in 1912 was begun March 18th. The actual manufacturing of pipe however was not started until March 28th. Since that date, the plant has been operated continuously up to the 27th of September and will doubtless be continued as long as weather conditions permit. The following table shows the results of the 1912 work up to and including September 27th:



C. M. & St. P. Ry.'s Concrete Pipe Plant at Tomah, Wis., Showing Stock of **Pipe.**

PIPE MADE.

Month	24 in.	30 in.	36 in.	42 in.	48 in.	Total
April	87	85	135		4	311
May	90	84	118		41	333
June	199	75	91		36	401
July	130	77	56		54	317
August	154	88	22		124	388
September	107	60	16		76	259
Total	767	469	438		335	2,009

No 42 in. pipe were constructed up to this date as the forms for this size of pipe were not received until a later date. The equipment for 1912 was the same as that used in 1911 except that the concrete mixer used in 1911 has been replaced with a smaller machine driven by an electric motor and equipped with an elevating hopper; also most of the wooden forms have been gradually replaced with steel ones. At the end of September 7-24 in., 4-30 in., 1-36 in. and 4-48 in. steel forms also 2-48 in. wooden forms were in use making a total of 18 forms of all sizes.

During weather in which the concrete sets rapidly, it has been possible to make a pipe per day with each form. Under favorable conditions, with the present equipment it is possible to make 18 pipe per day.

It has been found that the wooden forms get out of shape and in the long run are not as economical as the steel ones. They are however satisfactory as a temporary expedient. They also have the advantage of being lighter to handle than the steel ones. This fact is of some value where the handling of the forms is done by hand. This advantage, however, is to some extent offset by the additional number of pieces to be handled and therefore the increased cost in time of setting them up.

It is the expectation to erect a permanent plant at Tomah for carrying on the manufacture of pipe for about nine months out of the year. This plant was to have been erected this year, but the pressure of other work has delayed the completion of the plans and the carrying out of the work. When complete this plant is to be equipped with labor saving devices to insure the maximum output for the least expenditure of labor.

APPENDIX C.

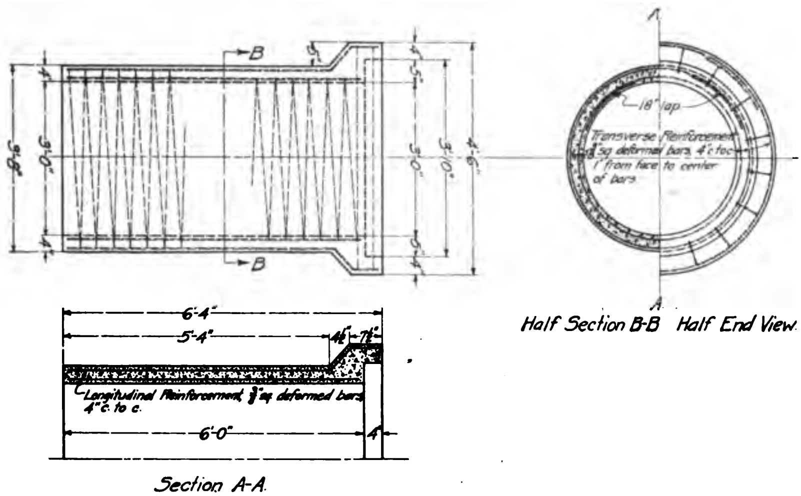
SPECIFICATIONS FOR REINFORCEMENT OF CONCRETE CULVERT PIPE, ILLINOIS CENTRAL R. R.

Cement:—Shall be of the brand or brands acceptable to and furnished in accordance with the specifications of the railroad company.

Workmanship:—Only workmanship of the highest quality shall be acceptable. Smoothness of finish and thoroughness of method throughout shall be required.

Aggregate:—The aggregate shall be of sand and crushed stone or gravel. All stone shall be a sound, hard clean stone crushed and screened so that none will pass through a sieve having one quarter inch meshes and so that all will pass through a screen having meshes one inch in diameter. All gravel shall be clean and free from dirt, and preferably graded in size from sand to pebbles about one inch in diameter. All gravel shall be of a size which will pass a one-inch screen. All concrete shall be mixed with the following proportions by loose measures:

Proportions of stone concrete—cement, 1½ bbl.; stone, 1 cu. yd.; sand, 0.45 cu. yd.; proportions of gravel concrete—cement, 1½ bbl.; gravel, 1 cu. yd.



Reinforced Concrete Culvert Pipe, Illinois Central R. R.

Mixing:—When the amount of pipe is sufficient to warrant it, the concrete shall be mixed by machine. When mixed by hand the work shall be done as follows: The stone and sand or gravel shall be spread on a water tight platform to a depth of 6 in.; on this the cement shall be evenly spread and the mass turned till of a uniform color. Water shall be added sufficient to make a plastic mass and the whole turned over and over till thoroughly mixed.

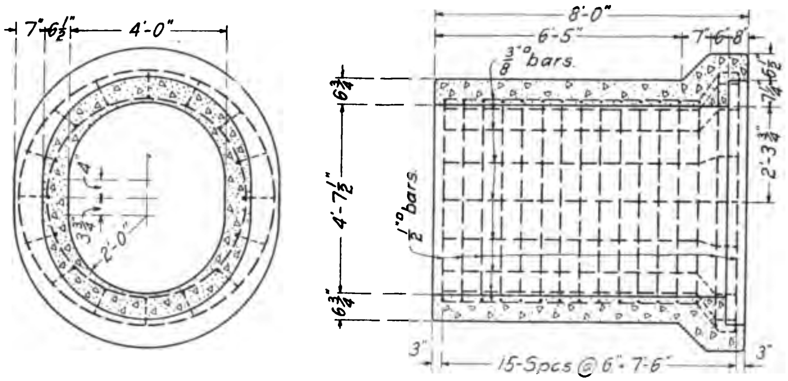
Deposition:—The most care shall be taken to prevent the formation of voids in any part of the pipe and to insure the thorough embedment of the reinforcement in its proper position until the concrete is placed around it. As the concrete is deposited, it shall be spaded or puddled along the lining of the mould on each face, so as to insure the smoothest possible finish. Every section shall be completely filled before any portion of the concrete has set.

Moulds:—The moulds shall be made true to plan and held rigidly in form during the process of depositing the concrete. They shall be lined with metal with all edges filleted and shall be well greased before each pipe is made.

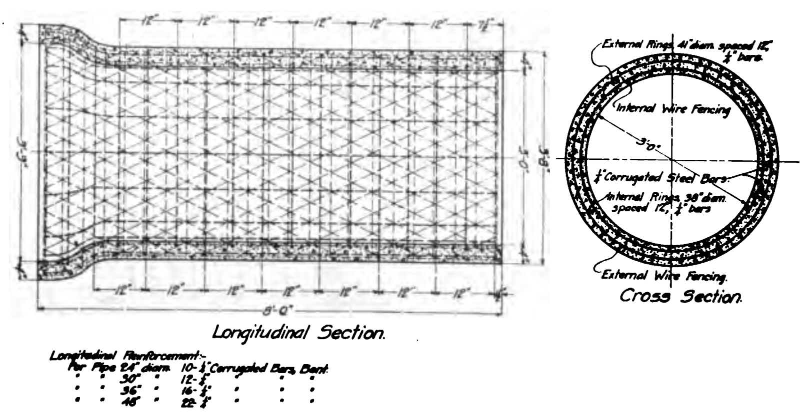
Reinforcement: 60 in. Pipe:—The transverse reinforcement shall consist of ½ in. square deformed bars of 50,000 lbs. elastic limit spaced not more than 4½ in. center to center. These bars shall be bent to a circle and the splice made by lapping the ends for length of nine in. and tightly wiring them together. The joints shall be placed so that they will come at the quarter points or points 45 per cent from the vertical or horizontal diameters of the cross section of the pipe and shall break joints so far as possible. The longitudinal reinforcement shall consist of bars of the same section as the transverse bars and shall be spaced 9 in. apart if round or 12 in. apart, if square. The longitudinal bars shall be suitably bent so as to extend into the bell and within two in. of the surface at the end. The bell shall be reinforced by two transverse bars of the same size as the others, spliced in the same way. The transverse and longitudinal bars shall be tightly fastened together so as to hold them in place during the deposition of the concrete.

48 IN. PIPE:—The transverse reinforcement shall consist of ⅜ in. square or round deformed bars of 50,000 lbs. elastic limit spaced not more than 3 in. center to center if round or 3⅞ in. center to center if square. The longitudinal reinforcement and the bending and splicing shall be as described for the 60 in. pipe.

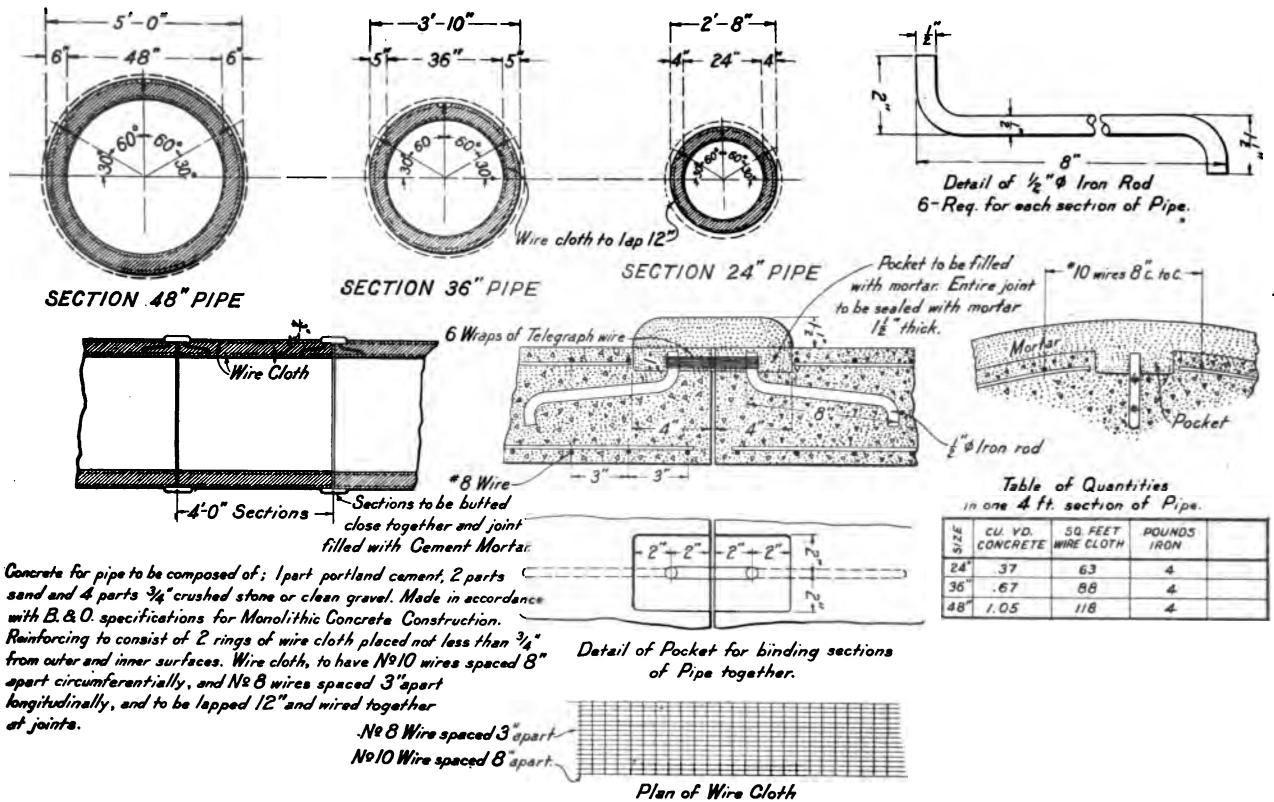
42 IN. PIPE:—The transverse reinforcement shall consist of ⅜ in. square or round bars spaced not less than 3⅞ in. center to center if round, or 4¾ in. center to center if square. The longitudinal bars shall be spaced 10 in. apart if round or 12 in. apart if square.



Reinforced Concrete Culvert Pipe, C. R. I. & P. Ry. and C. B. & Q. R. R.



Reinforced Concrete Culvert Pipe, Wabash R. R.



Concrete for pipe to be composed of; 1 part portland cement, 2 parts sand and 4 parts ¾" crushed stone or clean gravel. Made in accordance with B. & O. specifications for Monolithic Concrete Construction. Reinforcing to consist of 2 rings of wire cloth placed not less than ¾" from outer and inner surfaces. Wire cloth, to have Nº 10 wires spaced 8" apart circumferentially, and Nº 8 wires spaced 3" apart longitudinally, and to be lapped 12" and wired together at joints.

Table of Quantities in one 4 ft. section of Pipe.

SIZE	CU. YD. CONCRETE	SQ. FEET WIRE CLOTH	POUNDS IRON	
24"	.37	63	4	
36"	.67	88	4	
48"	1.05	118	4	

Reinforced Concrete Culvert Pipe, B. & O. R. R.

36 IN. TO 24 IN. PIPE:—The reinforcement of these pipes shall consist of No. 23 American Steel & Wire triangular mesh bent to circular form and adequately wired at the splice with not less than 6 in. lap, together with ⅜ in. round transverse bars spaced 12 in. center to center. These transverse bars to be so bent as to extend into the bell and within two inches of the surface at the end. The reinforcement of the bell shall consist of 2⅜ in. round bars bent and spliced as described for the 60 in. pipe.

ALTERNATE PLANS FOR REINFORCEMENT:—A circular concrete pipe having two lines of reinforcement may be used in place of the single line reinforcement, above specified, providing the pipe is of equal strength to that above specified and providing that in all cases the plan for the reinforcement, thickness of material, etc., is approved by the engineer.

DISCUSSION.

The President:—This report has been printed and distributed among the members; Mr. Hadwen is not here, but I think Mr. Decker is in the room and I would like to have him start the discussion.

Mr. H. H. Decker:—The committee on Reinforced Concrete Culvert Pipe sent out inquiries to a number of the roads and received replies from 42 different roads, only 15 of which gave much data in regard to the subject. We found from the data furnished that several of the roads were adopting this form of concrete construction for standard culverts under fills of all heights, and it was indicated that there was no difficulty in designing reinforced concrete pipe to meet all conditions of loading, to secure sections with diameters up to 48 inches. The types of pipe used by the roads varied somewhat. The six-ft. section was found to be used by most of the roads from which we received replies, although some used sections as long as eight ft. The bell and spigot joint generally used is similar to that on cast iron pipes. The reinforcing for the smaller sizes of pipe is woven wire fabric, and for the larger sizes, corrugated bars. A period of about thirty days is usually allowed for the seasoning of the pipe. These reports we have indicate that there is a saving of about 25 to 50 per cent in the use of concrete pipe over cast iron pipe. Very few roads have used concrete pipe for very many years. The Wabash has used such pipe for about five years which is, I believe, the longest of any road we had a reply from.

Mr. C. E. Smith:—I find on the Missouri Pacific that we can build reinforced concrete culverts three ft. x three ft. and up, cheaper than we can buy reinforced concrete pipe and we have

had quotations from a number of manufacturers. A three ft. x three ft. culvert has about the same cross section as a 42 in. pipe, which would seem to indicate that the culverts on our road and others would be cheaper from 36 in. down depending somewhat on the weight of the cast iron pipe the reinforced concrete is compared with. I have had men try to make comparisons with the very heaviest high pressure cast iron pipes, but I find that a standard cast iron pipe is satisfactory for our purpose and it is still lighter. We use a considerable amount of lock joint cast iron pipe. I have not been able to show any economy in the cost of reinforced concrete as against cast iron pipe, unless I assume considerable economy in the cost of installation and assume that it will not cost a good deal more to handle the concrete than the lighter cast iron pipe. As a great many members have had experience in putting in pipe, I would like to hear some comparisons in the cost of putting in concrete as against the cost of putting in cast iron pipe and also the cost of an equal area of each.

Mr. Reid:—We have had a little experience in placing concrete pipe on the Lake Shore, but we have used only 60 in. horizontal and 66 in. vertical diameter pipe which we make ourselves. The sections weigh about 7,000 pounds; they are six ft. long and the walls six in. thick. We handle them with our heavy capacity steam wrecking crane. I cannot say as to the cost, but they are rather expensive to handle and must be handled rather carefully. One cannot handle them as he can cast iron pipe. Cast iron pipe can be rolled off the car and down the bank, but concrete pipe must be lifted and placed with a derrick. We had some difficulty at first in placing them on account of getting the ropes right. We made a rope swing to go around the pipe and the pipe naturally settled down in the bed. In getting the rope off there was some displacement of the pipe. Recently we have made a hole in the top of the pipe, placing a rail through the pipe on the inside and have a bar or a loop through which the rail passed, fastened to the hook of the derrick. We can place the pipes in this way and be sure of keeping the vertical diameter vertical and having the joints connect. There is no disturbance of the pipe when we let go and remove the hanger. We have several of them in place and have had no trouble whatever with any of them. None of them have cracked. We have them under very heavy pressure and some of them reasonably close to the track.

We figure that they are cheaper than 60-in. iron pipe would be in those places.

Mr. Andrews:—Several years ago Mr. Graham, assistant engineer of bridges, our present engineer of bridges and myself designed a different type of concrete pipe. Up to this time we have used but little of it except the 36-in. size. This pipe is made without the bell and spigot ends in four ft. lengths, with the ends as near true as we could make them, in forms of our own design, made by the Blaw Centering Co. of Pittsburgh. Insets are provided instead of the bell and spigot which have a hook or a bar bent at each end which is cast or molded in the parts, projecting to about on a line with the outside surface, of the pipe. The pipe is laid in a six-in. bed of cement which comes up about half-way of the middle diameter of the pipe. The pipe is then laid end to end and the hooks which are cast in the pipe are brought into line and wrapped with telegraph wire. After this is done the layer of cement is carried all the way around the joint. Our object in this is to get a tight joint and to keep it from pulling apart. We all know from experience the great difficulty we have had in cast iron pipe of bell and spigot design pulling apart, and how difficult it is to get it together after it once pulls apart. Mr. Taylor made some 36-in. pipe on the Cumberland division ready to place, at $1.79 per lineal foot. Our engineer on the B. & O. S. W., having no knowledge whatever of what Mr. Taylor had done, made the same sized pipe ready to put in place, for $1.80 a lineal foot. Mr. Turner has lately made some of the same sized pipe at Locust Point, for a fraction less than $1 a foot. Now, comparisons are not necessary at all between that price and the price of cast iron pipe, but are necessary between that price and the price of the bell and spigot concrete pipe as sold to us by manufacturers, of which the 36-in. pipe runs about $2.75 per lineal foot, or practically a dollar more than the highest price it has cost us to make it. There is no patent on the pipe, and we do not expect or desire to make one penny out of it. It is open to anyone that wants to use it. In cast iron pipe, we use rejected water pipe, commonly called culvert pipe, which is rejected pipe of any character that is unfit for use as water pipe, and is laid aside and sold as culvert pipe. The question of the thickness or strength of the pipe we use is governed entirely by how far it is to be from the base of the rail. We are not in favor of concrete pipe where it comes close to

the rail, but our general officers have given us instructions to use concrete pipe whenever possible when the distance is sufficiently far below the base of the rail to overcome any danger whatever of breaking.

The Secretary:—This report, I believe, does not deal very much with pipe in larger sizes than about four ft. and there is considerable pipe used in larger sizes than that. Perhaps some of our members, or some here who are not members, may know of pipe in use considerably larger. I would like to ask Mr. Camp if he has any knowledge of pipe considerably larger than 48 in., in service?

Mr Camp:—I have heard of pipe six ft. in diameter, but I cannot recall now where it is used.

The Secretary:—Mr. Howson, I believe, can give us some information on that.

Mr. Howson:—I happen to be familiar with the practice of the Burlington. They had established their maximum size at 48 in., up to about four years ago when they went to a 60-in. standard where the waterway demanded it. Since that time they have used large quantities of 60-in. pipe. They use the bell and spigot pipe. In some cases, where there is danger of its pulling apart, they have wired through from one end to the other to hold it. They have a plant of their own for manufacturing large quantities of it near Aurora, Ill. They find quite a large saving in the price of concrete over cast iron, in some cases as much as half.

Mr. Andrews:—I omitted to say that in designing this pipe we went into the question carefully of cost. While approximate, our estimates showed that when we got beyond 48-in. pipe, the ordinary concrete culvert was cheaper; so we designed our pipe making 48-in. the maxium and 24-in. the minimum.

Mr. Reid:—In investigating the matter on the Lake Shore, before we started using the large concrete pipe, we found that above 48-in. iron pipe, the ordinary concrete culverts were cheaper. I think that is true in the case of the 60-in. concrete pipe we are now using. We use a 60-in. pipe, with a circular reinforcement, and the six-in. increase in vertical diameter brings the reinforcement bars to the surface where they are needed,—on the inside of the pipe at the top and bottom,—and outside on the sides. In regard to the maximum size of concrete pipe used, the city of Detroit, a year or two ago, built a large sewer in Center avenue crossing under our tracks, in which they used seven ft.

reinforced concrete pipe with a sort of lock joint. The end of the pipe was bevelled, I think, on the inner and outer corners so it made practically a socket joint. After being put in place they were rotated enough to bring a lock into position so that the pipes were locked together.

Mr. Killam:—We have used a great deal of concrete pipe on the Intercolonial during the last eight or ten years. We have had no trouble with the joints pulling apart. Our concrete pipes are all made in four ft. sections with lock joints which lap three in. Wherever the foundation is at all doubtful or where it is inclined to be soft, a bed of concrete is placed. The larger pipes are made with a flat bottom and are then placed on this concrete bed with concrete alongside the pipe, making almost a double concrete pipe. At the sides of the embankment a concrete abutment is built over the ends to a solid foundation. With this construction we have never had a joint open in any pipe on the road. We never put in a pipe that had been made only two or three months, but we like to have them made the year before. We have never had any broken pipes since they went in and there are probably three or four or five hundred culverts. On one section of the road between Quebec and River View, a distance of 115 miles, the masonry was poor and had shaken to pieces. We replaced it with concrete pipe with abutments at the outer ends of the pipes and though we got cast iron pipes at the Londonderry Works for half price, the concrete pipes were found to be cheaper and to serve just as well as the iron pipes. For this reason we have stopped using the iron pipe altogether.

Mr. A. S. Markley:—The use of concrete is beyond the experimental stage. The only question is to get it properly mixed; for men will get careless and over-confident. We have a lot of concrete pipe still in the track that was put in previous to our taking the road in 1888 and it is still in good condition. It is about 18 in. in horizontal diameter, about 24 in. vertically and about 2½ in. thick and is joined together with a miter joint with no reinforcing of any kind.

Mr. W. O. Eggleston:—I have in mind a couple of concrete pipes that are 60 in. in diameter, made in three ft. sections, six in. thick, with bevel joints, under fast, heavy track and are only 18 in. below the base of the rail. I was rather suspicious of them when I first found them and have looked at them whenever in that neighborhood. Last winter I went through both pipes and

found them in perfect condition. The fill is composed of sand.

Mr. A. H. King:—I notice in this report under the subject, "Seasoning, etc.," a certain paragraph, "Pipe can be unloaded by skidding from cars with snub lines and can be rolled down embankments with less danger of breakage than cast iron pipe." I am wondering if that had been duly considered. I believe I have heard some of the members say that cast iron pipe could be rolled from cars down embankments with but little danger of breakage on ordinarily soft ground. That has been my experience. We do not take a great deal of care in rolling cast iron pipe from cars. I would like to ask if it would not be necessary in all cases to provide some sort of a foundation where the concrete is used in shorter lengths than cast iron, on soft ground? In other words, if there is any settlement the joints will, of course, open up and the usefulness and life of the pipe, as a means of carrying water, will be impaired.

Mr. Smith:—If concrete pipe in four, six or eight ft. lengths is used, there is much more chance of the weight being concentrated on a shorter length of culvert, in which case the short length is liable to go down in a soft bottom and it appears to me that the concrete pipe will be much more liable to get out of surface and break apart than 12-ft. lengths of cast iron pipe. That would seem to argue for the necessity of the foundation Mr. Killam tells about. The cost of such foundations should be added to the cost of the concrete pipe and taken into consideration in getting comparative costs.

Mr. A. S. Markley:—Mr. King referred to breakage of pipe in unloading. In the case of iron pipe,—if the spigot end is landed first it is not so liable to break, but if the bell end strikes first it is far more liable to be damaged.

Mr. Killam:—I never saw any iron pipe broken in letting it down, but I have seen a number of concrete pipes broken in unloading, perhaps carelessly or by accident. I have observed that they will nearly always break into four pieces.

Mr. Alexander:—This discussion is now coming where I am glad to hear it. We have been told how cheap this pipe was made and how it was taken in preference to cast iron pipe, but I believe that the expense of handling and distributing it should be added to the difference in cost. We have used considerable cast iron pipe on our road and it is in favor with us. I have seen the concrete pipe used by other roads and have seen failures with

it. As has been said, this pipe is made in short sections which are sometimes broken in distributing. Sometimes the foundation is not properly made and they go all to pieces. When one adds the cost of making a good foundation and the extra cost of distributing, to the price, he is coming close to the cost of cast iron pipe. As we are in a timber country, we build wooden culverts, largely, on construction. These culverts are built large, so that we can replace them afterwards with cast iron pipe or line them with concrete built in place, which is preferable to any pipe with us. We use cast iron pipe in 12-ft. lengths and half lengths, with the bell and spigot joint up to 36 in., but then we find it is cheaper, as a rule to build concrete in place. We have some 48-in. pipe in special cases and we run down to 12 or 10-in. cast iron pipe. We can distribute our pipes very readily, with no breakage. We hardly stop the train to do it, because a freight train may run slow enough to allow pipe to be rolled off if there are no sticks or rocks for it to strike on. In my estimation this is the cheapest pipe with us, although I have been, perhaps, somewhat prejudiced against the concrete pipe.

The Secretary:—It is true that if the ground is soft any kind of a culvert will require some extra attention and expense in the matter of foundations. The extra expense for the foundation for concrete pipe should be but a very little more than that required for iron pipe. The Chicago & Northwestern has during the past few years rebuilt hundreds of waterways, using concrete culvert pipe, where wooden boxes or trestles formerly existed, and the saving over that if iron pipe had been used would amount to thousands of dollars. I think I am safe in saying that the cost of construction of concrete pipe culverts is from 30 to 40 per cent cheaper than when constructed of cast iron. Concrete pipe, properly made, ought to last many years but just how its life will compare with that of iron pipe time alone will determine.

Mr. King:—I want to confine myself to the subject and talk on concrete pipe, although, as a comparison, I favor the cast iron and we use it altogether on that part of the Harriman Lines with which I am familiar. I have yet to find where there has been any trouble from any kind of culvert pipe pulling apart, providing the foundation was perfect and there was no settlement.

The Secretary:—I would like to ask Mr. King if he puts end walls on any of the culvert pipe?

Mr. King:—Yes, we provide end walls as a rule and use end

walls where we have irrigation pipes. We make a distinction between the drainage culvert and irrigation culvert. In our country we have a great many irrigation culverts and end walls are put on mainly to prevent possible leakage outside the pipe. Frequently, where there is considerable fall at the lower end, a culvert washes and leaves the lower end unsupported. We then put in end walls which I think assists in holding the joints together. It is our common practice to use end walls.

The Secretary:—I asked Mr. King that question because many roads use end walls for all of their pipes. In case of a sliding bank, where the center of the embankment may be solid, the pressure of the sliding material against the end walls crowds them out, thus pulling the pipes apart at the joints.

Mr. Alexander:—We had iron pipes pull apart where the joints did not settle, and where there were no end walls. We have a good deal of frost in our country and some very sticky clay. If the fill is of new construction, it is likely to settle. The clay freezes solid to the ends of the pipe, and if a settlement comes while the clay is still frozen it will pull the pipes apart. We don't use an end wall as a rule, on a pipe, although we have put some end walls on tile pipes. The result has been that in some cases the clay has pulled up the end walls and broken the pipes, and we had to take them up. I would rather have pipes without any end walls on them unless they are necessary to keep the clay from running into the pipes.

Mr. Penwell:—I have never made any concrete pipes but there is one on our railroad that was there in 1900, when I became connected with this line. It was built with miter joints in three ft. lengths without any reinforcing. It is within 18 in. of the base of the rail and is in perfect condition. I expect every time I go there to find it flattened out and broken down, but it stands.

SUBJECT No. 8.

THE CONSTRUCTION AND MAINTENANCE OF LONG PIPE LINES FOR LOCOMOTIVE WATER SUPPLY, INTAKES, PIPE-LINES, PUMP-PITS, RESERVOIRS, ETC.

REPORT OF COMMITTEE.

Considering the subject in a general way the construction of a reservoir or dam depends largely on the existing conditions at the desired location. Where it is in a rock formation, such as is found in mountainous territory, concrete is the better material to use in the construction of a wall. This wall must be of sufficient size to withstand the maximum pressure of flood waters and to safely hold the required body of water to be impounded.

Where the formation is of soil and bed rock is at a depth such that concrete would be too expensive, a dirt reservoir can be constructed to impound the water very successfully. In this case the bank must be made not less than 10 ft. wide at the top and have a long slope on the outside which should be sodded with some grass that will grow successfully in that part of the country. A grass like Bermuda grass which is hardy and mats closely has been found to be the best in Arizona to keep the bank from washing. On the inside of the reservoir it is a good practice to cover the slope with gravel of sufficient coarseness to prevent the washing of the bank by the waves created by the winds. Where the soil is of a porous nature allowing the water to percolate through it, a stiff clay placed over the interior surface and well puddled will make the reservoir absolutely impervious to water. A convenient way to puddle a dirt reservoir is to corral a band of sheep for several nights in the reservoir when the clay is in a pliable condition. The sharp hoofs of the sheep will pack the clay better than any other method that can be applied. Cattle will do the same but not as effectively.

Pipes leading from reservoirs should be placed about 12 in. or a little more from the bottom and carried outside the wall to a pit of sufficient size to admit a man going down inside and working. A valve should be placed in this pit on the line leading from the reservoir into the pit and another valve on the supply pipe line. The pit should also have a depth of two feet below the intake pipe to allow any solids that may be drawn out of the reservoir to be removed, thus preventing their getting into the supply pipe line. In all lines leading from the reservoir through the wall great care must be used especially in a dirt wall to prevent any leakage by placing some suitable material around the pipe line, as no matter how small the leak is at first it is liable to develop at any time and utterly destroy a portion of the structure.

It is usually the case that water impounded for gravity supply has to be carried a long distance to the point of use through pipe lines. If such is the case, the ground for the pipe line should be carefully gone over and a survey made to endeavor to locate the line on an even grade without going into depressions or over rises. Where this is not possible air valves must be placed at all high points in the line to allow the air to escape, as the air will always rise to the highest point and if not allowed to escape will retard the

flow of water and eventually stop it altogether until the air is released. There are many air valves on the market and care should be exercised in the selection of the proper kind so that the attention necessary to keep in condition will be greatly reduced and less failure will occur in the water supply.

The selection of the pipe best suited for the pipe line depends largely on the nature of the soil. This must be considered in view of its chemical contents so as to provide the proper kind of pipe to withstand the corrosive action of the soil in which it is to be laid, some soil being so bad that it is necessary to use wooden pipes, which are used successfully for a great many years while in the same soil iron pipe will last but a very short time. A paint or dip put on the pipe will prevent corrosion for a great many years in some soils if properly applied. Asphalt dip is one of the best and when put on properly will keep the soil from getting at the body of the pipe for years. A satisfactory method is to dip the pipe in asphalt at the proper temperature, the pipe also being heated. After the first coat roll the pipe in sawdust and when hardened dip again. In this way a coat of asphalt over 1/8 in. thick will be taken on which will withstand the action of the soil for a long time.

A tee with a plug or a valve looking down should be placed in pipe lines leading from reservoirs at intervals along the line so that the line can be opened and the accumulation of foreign matter that may be in the pipe may be flushed out. If this is allowed to remain it will gradually decrease the carrying capacity of the pipe line to a very considerable extent and lines have been known to fill up entirely from an accumulation of silt in a few years.

The expansion of long pipe lines has to be taken into consideration and the regular expansion joint of about six inches transverse should be placed according to the varying temperature of the locality. Pipe lines should be placed underground at a sufficient depth to protect them from the action of frost or extreme varying temperature.

In the construction of a pipe line the first thing to be done is to prepare the ditch properly. The ditch should be dug to such a depth that the pipe will be below the frost-line when covered. This depth will vary according to the climate where the line is located. The trench must be level, or even on the bottom so that the pipe will lie firmly on the ground, otherwise it will settle, and cause leakage. This precaution is especially necessary when laying wooden pipe which should be driven firmly together, but care must be used to see that the joints are not forced too hard, as this tends to split the tenons away from the pipe. When backfilling, the utmost care should be used in tamping around and under the pipe so that no settling will take place, otherwise the pipe will settle both out of line and out of round.

The chairman found these measures necessary from personal experience, in laying 135 miles of pipe on what is known as the Bonito Pipe Line, for the El Paso & Southwestern Railway. On this work the greatest trouble with leakage resulted from irregularity in laying and backfilling.

Mr. J. L. Campbell, engineer in charge, found by investigation, that wood pipe under a pressure of 130 lbs. would give satisfactory service for 25 years, on which basis it was less expensive than cast iron and was therefore used. Cast iron was considered preferable to steel for pressures not exceeding 310 lbs. on account of its greater durability.

The following information concerning the Bonito pipe line is taken largely from a description by J. L. Campbell in the Proceedings of the American Society of Civil Engineers, Vol. LXX, Dec., 1910:

Wood Pipe:—Machine made, spirally wound, wood-stave pipe, made in sections from 8 to 12 ft. long, with the exterior surface covered with a heavy coat of asphalt, was selected in preference to unprotected continuous stave pipe as the diameters were not so great as to require the latter. The pipe is wound with flat steel bands, of from 14 to 18 gage and from one to two in. wide. The machine winds at any desired pitch and tension. At each end, the spiral wind is doubled back two turns, the second laying over the first and developing a frictional resistance similar to that of a double hitch of a rope around a post. The ends of the bands are held by screw nails or a forged clip, the latter being the better. This clip has two or three spikes

on the underside which set into the stave and two side lugs on top which turn down over the band. The latter pass twice over the seat on the clip, the first turn holding the clip to the stave while the second turn is held by the lugs, which are hammered down over it. The end of the band is then turned back over the clip and held down by the staple.

The staves are double tongued and grooved and from 1⅜ to 2 in. thick. The smallest thickness is sufficient. The exterior face of the staves should be turned, concentric with the axis of the pipe to form the circle so that the band will have perfect contact with the wood.

The joints are formed by turning a chamber in one end of the pipe, and a tenon on the other, or both ends are turned to a true exterior circle and driven into a wood or steel sleeve. The tenon and chamber were used in this work. Finally, each piece of pipe is covered with as much hot asphalt as it will carry.

Steel Bands:—The specifications required bands of mild steel of 60,000 lbs. strength, with an elastic limit half as great. The winding was spaced to limit the tension to 15,000 lbs. per sq. in.

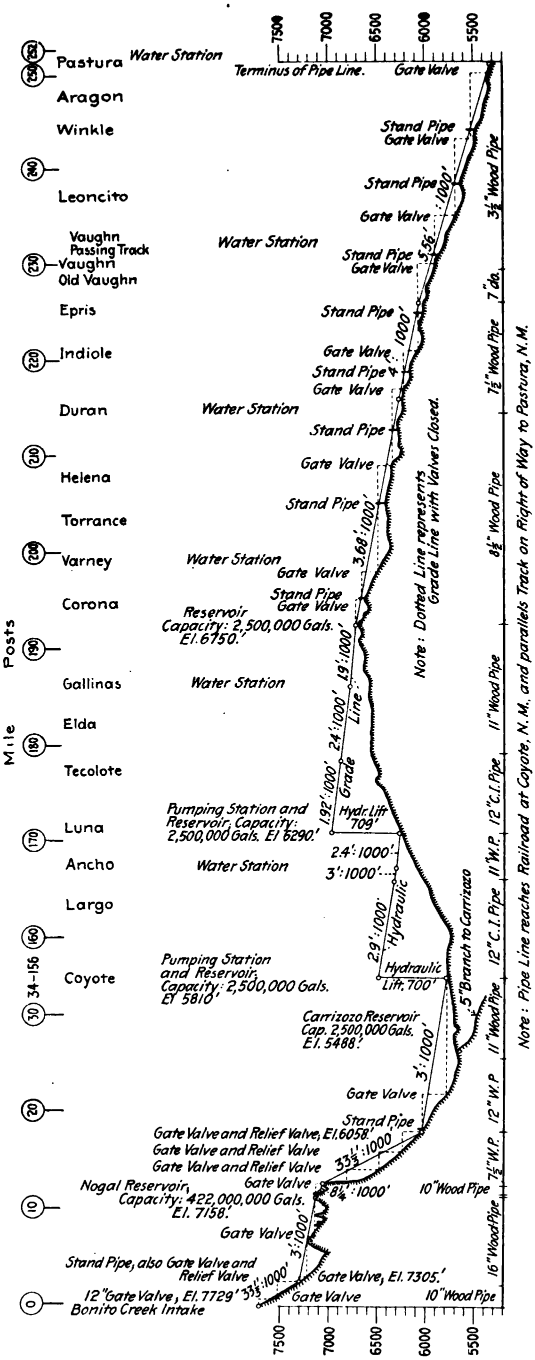
If severe water hammer is present, the ordinary working stress should be materially less than the latter figure, otherwise the spiral bands will stretch enough to permit the water to spurt out between the stays. This was determined to be true on 4,500 ft. of 12-in. pipe connecting the Carrizozo reservoir with the water column at the round house there. In pumping tests at the mills, attempts were made, at various times, to burst the pipe, but they never succeeded. Before the elastic limit was exceeded, the water was running out between the staves as fast as the pump forced it in. On the following day, the pipe thus tested would carry the pressure for which it was designed. Except for defects in bands, pipe of this kind will not burst in the service for which it is properly designed. This is true, without exception, of the 100,000 pieces in this service.

Wood Staves:—The staves of this pipe are of Michigan and Canadian white pine. This pine cannot now be had of clear stuff, or in long lengths, in large quantities; otherwise, it is unexcelled. Douglas fir and yellow pine, coarser and harder woods, have the advantage of clear lumber and long lengths. Cypress is not as plentiful and redwood is costly. The mill tests did not determine definitely the minimum degree of seasoning necessary, and press of time compelled the acceptance of some rather green lumber. Service tests do not show that there is any abnormal leakage from pipe made of such lumber and it could not now be distinguished in the trench by such tests. Undoubtedly, however, thorough air seasoning should be required.

Bored Pipe:—Owing to its small size, a part of the 3½ in. pipe was bored from the log. This was a mistake, for bored pipe has a rough interior and a reduced capacity. The inspection and culling are difficult and unsatisfactory and imperfections readily apparent in a stave frequently escape detection in bored pipe.

Pipe Joints:—The chamber and tenon of this pipe is an all-wood joint 4 in. deep. An iron sleeve makes a better and stronger joint as it compensates for any initial tension in the banding over the chamber of the wood joint, and secures full advantage of the swelling of the wood. Cast iron is better than steel, as it is more rigid and its granulated surface breaks up the smoothness of the wood surface swelling against it. One objection to the cast iron sleeve is that of cost, but it adds 4 in. to the effective length of every section of the pipe as compared with the wood joints. On the Pacific coast, the banded wood stave sleeve is used with success.

Coating:—To preserve the banding from corrosion and the wood from exterior decay, the pipe is thoroughly dipped in refined asphalt, having a flow point adjusted to the prevailing temperature during shipment and laying. One grade can be used through a considerable range of temperature, as the coating used on this work endured a 2,000 mile shipment successfully.



Condensed Profile of Bonito Pipe Line, Bonito Creek to Pastura, New Mexico, El Paso & Southwestern System.

Each piece was carefully inspected along the trench and any break in the coating was thoroughly painted with hot asphalt, enough of the latter being sent from the factory in barrels with the pipe. The first 37 miles of this pipe has been in service for four years. Recent inspections show the coating to be in excellent condition and the steel underneath to be bright and clean, although in some cases, where the initial pressure and leakage between the staves of the dry pipe were great, the escaping air and water lifted the coating into bubbles. At some points where the lifting was great enough to rupture the asphalt and the soil is heavily charged with alkali some corrosion has begun.

The integrity and impermeability of this asphalt coat are quite as vital as constant saturation as this coating protects the entire pipe from exterior contact with destructive agencies. With such effective exterior protection a constantly full pipe is not so imperative. In the exterior protection of the wood, this coated pipe has quite an advantage over continuous stave pipe.

Cast Iron Pipe:—Beginning at the first pumping plant at Coyote at mile 156, and running up to mile 166 and again commencing at Luna pumps, mile 171 and extending up to mile 179, the minimum pressure on those portions of the pump main is more than the 130 lbs. per sq. in. allowed for wood pipe, and the final estimated maximum pressure ran up to 310 lbs. The selection of pipe for these pressures was first between steel and cast iron and, second, between the lead joint of the standard bell and spigot pipe and the machine iron joint of the universal joint pipe. Again the choice was between lead and leadite, for the bell and spigot pipe. Cast iron was selected because of the certainty of its long life and the bell and spigot pipe was selected on the basis of comparative cost of pipe laid. The standard lead joint was chosen on the result of tests. This cast iron pumping main has a diameter of 12 in. throughout.

Pipe Joints:—There was a question of the reliability of lead joints at 300 lbs. pressure. A section of 12 in. pipe was laid with standard joints containing 22 lbs. of lead and tested up to 500 lbs. pressure without a sign of failure or leakage. The joints were caulked down 3-16 in. below the face of the bell. Of the 8,700 joints thus made in the field, not one has blown out or failed. A few leaked slightly on top and they were made permanently tight by additional caulking. The present maximum pressure is 278 lbs. These joints are standard joints specified by the New England Water Works Association. It should be borne in mind that there is no water hammer in this line. In 8,700 joints, 198,000 lbs. of lead and 3,200 lbs. of oakum were used, or 22.76 lbs of lead and 0.37 lbs. of oakum per joint.

Leadite was tested in competition with the lead but it leaked at 100 lbs. and failed under a sustained pressure of 300 lbs. It is a friable material and cannot be caulked successfully, while its principal ingredient appears to be sulphur. The failure was by slow creeping out of the joints. It is melted and poured, but not caulked. It has attractive features for low pressures and for lines not subject to movement or heavy jarring.

Air Cushions:—To prevent water hammer on the pumping main, all pumps are provided with large air chambers. In addition, and as a special feature for absorbing the shock of pumping under a high pressure through a pipe 21 miles long, a large air chamber in the form of a closed steel cylinder, 5 ft. in diameter and 15 ft. long is mounted on the pumping main outside the pump-house. This cylinder is set on its side with concrete collars, directly over the pipe beneath, to which it is connected by a 12 in. tee, in which a 12 in. gate valve is set. The cylinder is provided with a glass gage cock, etc., and was designed for a working pressure of 3C0 lbs. It has proved to be entirely air and water tight. As indicated by sensitive gages on the pump main, just beyond these large air chambers, the latter absorbs all the water hammer which gets beyond the air chamber, on the pumps.

Pumping Plants:—The pumps at Coyote and Luna are Nordberg-duplex, cross compound, condensing, crank-and-fly-wheel machines, with six-inch

plungers, traveling 600 ft. per minute, at full normal speed, and designed to work again at 300 lbs. per sq. in. They have a guaranteed efficiency of 135,-000,000 ft. per 1,000 lbs. of steam at 150 lbs. and super-heated 75 deg. One hundred twenty-five h. p. Sterling water-tube boilers are used, with Foster super-heaters and 33-in. stacks, 100 ft high. Each plant is provided with complete duplicate pump and boiler units, only one set working at a time. The pump building is a substantial concrete brick and steel structure, 50 ft.x80ft. in plan, with a fire wall, with two steel doors, dividing the floor space into an engine room 50ft.x50ft. and a boiler room 50ft.x30ft. The two plants are exactly alike.

Pipe Line Leakage:—There is no measurable leakage from the iron pipe. By thorough inspection and measurements at the end of two years, leakage on the wood pipe between Coyote and the Bonito Creek, from 11 in. and 12 in. pipe was found to be as follows:

On 8.6 miles of 11 in. pipe, 146,600 gal. leakage per day equals 17,046 gal. per mile. Four miles of 12. in. pipe, leaking 14,829 gal. per day, equals 3,702 gal. per mile. The 7½ in. pipe on this section, appears to be leaking less than the 12 in. pipe.

There is no material leakage from the 10 in. and 16 in. pipe between Bonito Creek and Nogal Reservoir, as determined by velocity and volumetric measurements hereafter described. The greatest probable error in the velocity measurements would not exceed ½ per cent. If such an error existed and was all charged to leakage, it would amount to but 17,204 gal. per day, or 1,582 gal. per mile, out of daily delivery of 3,784,000 gal. The measured discharge of the pipe as determined by the velocity was 5.84. sec. ft., while the mean maximum volume of water over the weir at the end of the pipe is recorded by the weir as 5.88 sec. ft.

From Coyote, east along the railway, the wood pipe is remarkably tight. The rate of leakage from it, as determined by 600 observations uniformly distributed, was as follows:

11-in. pipe equals 120 gal. per mile per day.
8½ and 7½-in. pipe equals 268 gal. per mile per day.

The observation was made by uncovering the pipe and measuring the leakage for 10 minutes. A graduated glass measuring to drams was used. The rate of leakage varied from 5 drops to 45 oz. in 10 minutes. Of the joints uncovered, 57 per cent were found to be leaking. It is rather remarkable that, in the large leakage in the 11 and 12 in. pipe between Coyote and Bonito only one out of every eight joints was leaking, indicating a physical defect in such joints. The largest leak found on one joint was at the rate of 17,280 gallons per day. Leakage between or through the staves is not measurable. The significant leakage of 120 gallons stated above is from the 11 in. pipe in the pumping main between Coyote and Corona. The present maximum pressure on it is 100 lbs. per sq. in. All the figures given above include visible or invisible leakage, the latter being such as does not appear on the surface. The visible leakage is but a small part of the total.

Cost of Pipe Laying:—Between Bonito and the railway, one gang of ten men could lay 4,000 ft. per day, though the average was much less, owing to a variety of causes. At the end, the railway company added to the contractors' force, and laid the last ten miles of pipe in seven days, there being six separate gangs at work.

Along the railway, the day's record on wood pipe was 4,000 ft. of 11 in., 6,200 ft. of 7½ in. and 8,345 ft. of 3½ in. pipe laid by a gang of eight men after the pipe was distributed along the trench. These eight men, of whom five were Americans, laid 76 miles of pipe, and became expert, their operations becoming like clock work.

On the 12 in. iron pipe, the regular day's work was 96 joints or 1,152 ft. of pipe, laid and caulked. The record was 1,644 ft., while two gangs laid 101,300 lin. ft. in 60 days. These gangs consisted of one foreman, one in-

spector, eight caulkers, four yarners, one melter, one pourer, one helper, and ten men putting pipe into the trench.

The pipe from Bonito to the railway was laid by contract. The price was 18 cts. per lin. ft., laid and backed-filled from the Lake to Nogal reservoir, and 28 cts. from Nogal to Bonito, in addition 50 cents per ton per mile was paid for hauling pipe, and extra compensation for setting valves.

From Coyote, east along the railway, the work was done by the railway company under the direction of Mr. J. L. Campbell, chief engineer. The total cost of laying 384,300 ft. of wood pipe from 11 to 3½ in. in diameter was $18,156, or $0.0472 per foot divided as follows:

Ditching,	$ .0249
Laying,	.0113
Backfilling,	.0110
Total,	$ .0472

This includes unloading from cars. Train service costs one-third cent per foot additional.

The pipe gang including back-filling, consisted of one foreman at $100 per month, one assistant foreman at $75 per month and about 30 Mexicans at $1 per day. The rates were the same in the ditching gang. The plow team cost $6 per day. Including all general expenses, the cost does not exceed $.06 per lin. ft.

The cost of laying 101,300 ft. of 12 in. cast iron pipe was $23,826, or $.235 per foot, divided as follows:

Ditching	$ .0249
Laying,	.1180
Backfilling,	.0110
Lead,	.0790
Oakum,	.0014
	$ .2343

This includes train service and unloading pipe, but nothing for tools. The foreman and inspector received $100 per month, the caulkers $3 per day, the pourers $3, the melters $2.50, two pipe men $2, and laborers at $1 per day. This work is standing perfectly under 275 lbs. pressure.

The cost of the pumping plants complete per horse power is as follows:

Pumps,	$79.00
Boilers,	18.70
Building,	41.70
Total,	$139.40

The approximate cost of storage capacity is as follows:

Nogal store reservoir,	$ 103.00
Carrizozo service reservoir,	3,040.00
Coyote service reservoir,	2,880.00
Luna reservoir,	3,480.00
Corona reservoir,	2,720.00

To cover general expenses, three per cent should be added to all costs above given. The cost per foot of pipe laying includes the setting of all specials, valves and stand pipes. The total cost of the pumping stations is $167,292.

The difference in cost in laying 11 in. and 3½ in. wood pipe is not nearly so great as the difference in diameter or the total quantity laid on record days. While the records are 4,000 ft. and 8,345 ft., the 76 miles of pipe of all diameters were laid in a total time, including all delays of 223

days or an average of 1,723 ft. per day. The cost of the 11 in. pipe is covered by $.07 per foot. The pipe was laid by a single gang as fast as it was received from the factory.

In caring for wooden pipe lines, the utmost care should be taken to keep the line full of water all the time, as that is one of the most important things in the preservation of wooden lines. In maintaining an even pressure on the line, gate valves should be placed in the line, to regulate the flow of the water, when the line is not carrying its full capacity to prevent it from drying out, thus causing it to leak and decay. In order to do this, automatic air valves were placed on high points to allow the air to escape so that the line may properly be filled with water, by closing down on the gate valves to fill the line with water. In all low places, mud valves were inserted for the purpose of washing out the line, when sediment has accumulated sufficiently to make it necessary.

To prevent bursting the pipe, relief valves or standpipes were provided so that excessive pressure will release automatically and overflow the standpipe, should any obstruction occur in the line. This has proved a satisfactory arrangement as no bursts have resulted from obstructions but the standpipes and relief valves have frequently overflowed, indicating that there was some such obstruction. By applying a gage along the line one could tell just what pressure was carried. One could also estimate the amount of water being delivered. Later, weirs were placed at the pumping reservoirs so that the amount of water delivered was checked as it flowed into each reservoir and it was possible also to check against the pumps, showing any deficiency that took place from slippage of the pumps or from leakage in the valves.

THE INTAKE:—It should be so arranged that there are apartments for settling the silt and sand before it enters the head of the line. The water must be drawn from near the top of the intake to prevent the drawing of silt and sand and it should be built to allow flushing and cleaning when necessary. When the water is first turned into the wooden line it is a good plan to place a large quantity of wheat bran in the head of the line as this settles in small cracks and forms a paste which stops a number of small leaks. It coats the pipe and does not injure the water. About one sack to each mile of 10 in. pipe is advisable.

MAINTENANCE OF THE LINE:—A close estimate has proven that the cost of maintenance is $.25 per mile per day or $.05 per 1,000 gallons delivered, in its full capacity. All water delivered from this line to tanks is controlled by automatic valves and requires very little attention.

Where the water is taken out the line is reduced to carry the same pressure below the delivery, which accounts for the different sizes of the pipe used in the construction of this line.

REPAIRS:—Wooden pipe can often be repaired by placing bands around the pipe with lugs and nuts. These are adjustable and can be drawn up to prevent leakage between the staves. When small leaks appear, in joints or defective pipe, they can readily be repaired by using soft wood as wedges and caulking them. It is much easier to repair breaks in the wooden line than in the iron, should any occur, for in the iron line it is absolutely necessary to take out broken joints and replace them with new pipe which is expensive, as each joint must be melted and the new pipe releaded. One can often repair broken cast iron pipe with bands, but it is not so satisfactory. The wooden line can be repaired without draining the line.

In rough country away from the railway, as some of this line is located, it would have been almost impossible to have used an iron line, owing to the cost of delivering the pipe along the trench, as a great deal of the pipe here had to be handled by hand. Consequently, a wooden line is preferable to iron in rough country as it can be replaced for less than the interest on the cost of an iron line.

RESERVOIR CONSTRUCTION:—There are four 2,500,000 gallon concrete reservoirs and one natural reservoir on this line. Two of these were con-

structured without being reinforced and gave way, causing considerable trouble. The other two were reinforced with ⅜ in. rods, spaced 12 in., center to center, throughout, and lapned 30 diameters. These reservoirs are 100 ft. x 200ft. in size and 16 ft. deep. They are covered with cement 4 in. thick, with a core of 18 in. of concrete used around the edge of the bottom and sides to prevent any settling. Soap and alum were applied to the cement as water proofing. The surfaces were afterwards heavily coated with asphalt and Elaterite paint to fill any cracks that might develop in the concrete, and this has proved effective. Great care was used to tamp all soft ground solid before putting in the concrete to avoid any breaks from the earth settling under the concrete. These tanks are constructed on a slope of 1½:1, with the coping 6 in.x18 in. around the top to prevent water from running underneath the concrete. The ground was sloped from the coping and well tamped to make the drainage perfect away from the concrete.

WATER STATIONS ON THE WESTERN AUSTRALIA GOVERNMENT RAILWAYS.

E. S. Hume, chief mechanical engineer:—Water supply for railway purposes is a question of first importance to officers in administrative charge of the railway system of this state. The long dry summers make it very difficult to provide a sufficient supply for all wants at inland depots, and the quality of the waters obtainable in many districts is very detrimental to the locomotive boilers. The sources of supply are of many kinds—natural rainfall catchments conserved in large dams or tanks, wells, lakes, river pools, and the Goldfields water supply main.

When a dam is constructed in a clay soil it is unlined, but where the soil is porous a cement or asphalt lining is applied. At Menzies, a Goldfields center, a dam of 7,371,000 gal. capacity is lined with cement, and also covered over with galvanized iron to reduce evaporation, which was found to be equal to seven ft. during the summer months. Great care is taken to prevent the catchment areas from becoming polluted, the land being reserved and cleared for the purpose. In some instances, particulars of the more important of which are given hereafter, the water is pumped through lengthy pipe lines to overhead receiving tanks, generally of 25,000-gal. capacity. These tanks are of cast iron, carried on staging, the staging being either a wooden or steel structure as found most convenient in the circumstances. The pipe lines are usually of cast iron three to six in. in diameter, with the ordinary spigot and faucet lead joints. These are cleaned periodically by passing brushes made specially for the purpose through the entire length of the pipe line. These brushes are of wire, similar to those generally used for cleaning boiler tubes, and several of varying diameters are mounted on a rod at the back of which a stout leather washer is placed, which acts as the driver when water pressure is applied. Engines take their supplies from water columns connected to the cast iron overhead tanks by 6 in. cast iron piping. Worthington double-acting pumps are in general use in connection with these supplies, and floating foot valves are provided in each case on the suction pipe to prevent any solid matter getting into the pipes.

In many districts the waters are of such a nature that serious damage to boilers would result from their use. The attached analyses are examples of such waters. By distillation, treatment with caustic soda, carbonate of soda, caustic lime, filtration and other means, each adapted to the particular water in question, the feed waters are kept fit for their purpose, but great watchfulness and care is necessary at all times in this regard. A few plants have been installed to automatically deal with waters naturally unsuitable, these including Mirlees-Watson "Yar Yan" distillers, and Kennicott and Archbutt-Deeley softeners, but generally waters are treated by means of locally-built measuring vessels placed on top of the overhead storage tanks, which automatically introduce the re-agent into the delivery from the main. The analyses on the accompanying table give a typical instance of water before and after treatment by this latter method.

WATER ANALYSIS.

WESTERN AUSTRALIA GOVERNMENT RAILWAYS. LOCOMOTIVE TESTING DEPARTMENT.

SAMPLE.	Alkaline Chlorides.	Alkaline Sulphates.	Alkaline Carbonate.	Alkaline Hydrate.	Magnesium Chloride.	Magnesium Sulphate.	Magnesium Carbonate.	Calcium Chloride.	Calcium Sulphate.	Calcium Carbonate.	Iron Oxide & Alumina.	Silica.	Organic Matter.	Oil.	Total Solids Grains per Gallon.	Hardness in Degrees Total	Hardness in Degrees Temporary.	Remarks.
Mundaring Water, (G.W.S.)	13.3				2.98		.14		trace	1.25	.14	.28	trace		21.0	4.5	1.4	Waters known to have caused considerable corrosion of pipes.
Do.	26.16				4.97		.15		1.94	.48	.33	.28	"		34.9	7.32	.7	
Victoria Reservoir, (Perth)	14.0				1.33		.92		.91	.33	.07	.49	"		21.0	4.1	1.4	
Chidlow's Well,	25.9				5.03		.20		1.85	11	.15	.15	"		33.4	7.1	.4	Do.
Karalee Dam Water,	1.73						.11		.6	.62	.14	4.48			7.68	1.0	6.2	Waters which have not caused corrosion of pipes.
Malcolm Dam Water,	4.8		trace				1.42			2.0	.07	.07	2.14		10.5	3.7	3.7	
Victoria Reservoir. Treated	15.4	94	"				1.47			1.17	.14	.14			20.3	2.64	2.64	Treated for use in boilers to prevent corrosion. Soda used.
Do. Untreated	14.0				1.33		.92		.91	.33	.07	.49	trace		21.0	4.1	1.4	
Mundaring Water, Treated.	18.4		2.6												27.0	2.6	2.6	
Do Untreated	15.6				2.66		.73		1.31	.55	.21	.35	"		26.0	5.2	1.4	
Lake Matilda Water,	11.1		2.03				2.49			1.92	3.84	.4	2-4		25.2	4.9	4.9	
14																		E. S. Hume. C.A.L.

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Water Analysis, Accompanying Report of E. S. Hume, Western Australia Government Railways.

The following are a few of the more important boiler feed water pipe lines installed in this state:

Mount Malcolm is situated about 140 miles from Kalgoorlie, the chief Goldfields center, the latter being distant 375 miles from the seaboard and capital city. Water is stored in a dam estimated to contain 100,000,000 gal. when full, sufficient for a two years' supply without replenishment. A 10in.x10in. Worthington pump with a 6 in. diameter water end is utilized to force water through a 5 in. cast iron S. and F. main 7 miles long, laid underground the entire distance, and delivering into a 25,000 gal. standard overhead tank at a rate of 6,000 gal. per hour. At present it is only necessary to pump every second day to keep pace with requirements. The water is of excellent quality and the plant has been in operation for seven years without any maintenance cost.

Chidlow's Well is a wayside station situated 29 miles from Perth on the main Goldfields line, and is the principal watering depot outside of the metropolitan area. A dam formed in a valley by means of a weir, and holding 117,000,000 gal. is 1¾ miles distant from the station yard, and the connection is by a 5 in. cast iron S. and F. pipe delivering into two 25,000 gal. overhead tanks. A Worthington 12"x12" pump with a water end 7 in. in diameter and a 6 in. suction pipe, delivering 12,000 gal. per hour against a 190 ft. head. This plant has been in use for 12 years, and about 18 months ago its efficiency had become reduced by 3,500 gal. per hour owing to incrustation in the pipes, and the pressure to be overcome by the pump had been increased by 40 lbs. The consumption of fuel had also increased, but after the pipes had been cleaned by means of the brushes previously referred to, the plant regained practically its original efficiency. The delivery is again becoming restricted, showing that it is advisable to clean the pipes about every 18 months. The water in this dam contains corrosive constituents, and requires to be consistently treated, as will be seen by reference to the attached analysis. It is noteworthy that on the watershed at this place where trees, mostly gum trees, are growing, the water flowing into the dam contains only 4 to 6 grains of salt per gallon, whereas where the timber has been killed the salt contents are as high as 240 grains. Drains have been carried through such parts of the catchment area as are high in salt, and trees of a serviceable nature, such as may be used in the construction of cars or wagons, or fruit cases, etc., are being planted to absorb the natural salt from the soil.

Lake Matilda is situated 285 miles from Perth on the Great Southern railway, and is a large natural storage of water estimated at 200,000,000 gal. A Worthington pump 7½"x5", with a 6 in. water end pumps through 1½ miles of 4 in. galvanized iron pipe into an overhead tank of 25,000 gal. capacity. This overhead tank is constructed very cheaply, being of thin galvanized iron of circular form, flat bottom, and sweated joints. It is generally known here as a "squatter's tank," and is the latest introduction to reduce cost on sheep or cattle runs, or ranches. This supply has only been tapped within the last three months, but the water is very free from deleterious constituents, and the cost for maintenance should be very low.

Karalee, situated about 280 miles from Perth on the main Goldfields line, is supplied with water from an underground tank of 10,000,000 gal. capacity. A 6"x4"x6" Worthington pump operates through 2¼ miles of 3 in. cast iron pipe, against a 120 ft. head, delivering into a standard overhead tank at the rate of 2,500 gal. per hour. The catchment in this case is principally rock granite, and the water is collected into cement drains or stone gutters to the storage tank. The water is practically pure.

To furnish Goldfields, about 375 miles from Perth, with a plentiful supply of good water, the Government of Western Australia built what is known as the Coolgardie Goldfields water supply scheme. The scheme in the first instance comprised a pipe line of 30 in. internal diameter, 351½ miles long, with suitable impounding and service reservoirs. The source of supply is the Helena river in the Darling ranges, where a reservoir 760 acres in extent, with a capacity of 4,600,000,000 gal., and a catchment area of 569 square miles, was formed about 18 miles from Perth by the construc-

tion of a concrete weir 100 ft. high and 755 ft. long. The main is of the locking bar type, constructed of 1/4 in. steel plate for pressures not exceeding 390 ft. head, and 5-16 in. for greater pressures. Eight service reservoirs were constructed of 1,000,000 gal. capacity, at each of which a pumping station is located. The water is pumped from the main reservoir through each service reservoir, until it is finally delivered into a main service tank of 12,000,000 gal. capacity, situated 307½ miles from the Helena reservoir, and 1,290 ft. above the original intake. From thence the water flows by gravity to Kalgoorlie, an additional 44 miles. The pumps were capable of delivering 5,600,000 gal. per day of 24 hours, and the friction head was found to be 2.85 ft. per mile, delivering that amount. Work was started in connection with the scheme in 1898, and water flowed into Kalgoorlie in January, 1903.

The pipes were thoroughly and carefully coated with a mixture of coal tar and Trinidad asphaltum before laying, but in 1905 signs of corrosion became apparent, and leakages took place through pit-holes in the pipes in June of that year. It was observed later that the friction head was increasing in certain sections, and on opening up in these sections it was found that serious corrosion was taking place. Many attempts were made to combat this deterioration by cleaning and re-coating the pipes, but these were not satisfactory. The water was now being used extensively in locomotive boilers, and without treatment the boilers were being seriously injured by corrosion. The composition of the water at that time was as given in the accompanying table. Steps were taken to treat the feed water by a re-agent to neutralize the effect of the corrosive elements. The treatment by caustic soda, and lime in others, was quite successful when regularly and systematically applied, and the writer suggested to the administration in August, 1908, that lime treatment in the Goldfields main would probably result in an equally beneficial effect. After consideration, the matter was finally referred to an English board of experts, who recommended that measures be taken to prevent air from entering the main throughout its length; that a balancing reservoir be provided to cope with the seasonable fluctuations of demand; that an apparatus be established near the Helena reservoir to de-aerate the water entering the main, and that 3 grains of lime per gallon be added to the water. These recommendations were very fully considered, and an advisory board, of which I was a member, recommended to the Government that lime treatment only should be tried in the first instance, in view of the good results obtained by this means in several smaller pipe lines. This recommendation was approved and is being carried out, so far with good results, but no final conclusion has been arrived at.

As an indication of the benefit of lime treatment, a 6 in. Mannesman pipe line 12 miles in length which conveyed the above water from Kalgoorlie to Kanowna, and which after two years' service commenced to exhibit internal perforations until these perforations reached 18 per month, was so treated. On the introduction of lime the perforations fell to an average of five per month, from that to two per month, and during the last eight weeks of observation no perforations took place. This result was achieved 10 months after the first initiation of lime treatment on the 12-mile section.

Returning to the general practice for pipe lines in railway supplies in this state: Where piping required for suction or delivery pipes is less than 3 in. inside diameter wrought iron or steel pipe is used with ordinary screw ends screwed into ordinary tap couplings, flanges being used where the pipe is attached to pumps.

SPECIFICATIONS FOR A STANDARD WOOD PIPE LINE DESIGNED FOR A PRESSURE OF 80 POUNDS.

CHARACTER:—This pipe shall be machine made spiral banded wood stave pipe.

STAVES:—The staves shall be made of live, clear, straight grained and sound pine, fir, cypress, cedar or redwood, thoroughly seasoned, out of wind

and free of knots, checks, shakes, pitch pockets or streaks and worm, insect or bird eaten or bored wood. They shall be accurately milled and planed to perfect line and surface on all sides and edges and shall have a finished thickness of 1¼ in. The interior and exterior faces of the staves shall be finished to true circles concentric with the longitudinal center axis of the pipe. The edges of staves shall be cut on lines radial from the center of the pipe. A semicircular or V-shaped groove about ⅛ in. wide and deep shall be cut longitudinally the full length of the stave on the midline of one edge. On the other edge, a bead of corresponding location, size and shape to completely fill the groove shall be cut.

BANDS:—The pipe bands shall be round and they shall be made of pure iron containing of

Sulphur, not more than .020 per cent
Carbon, not more than .020 per cent
Phosphorus, not more than .005 per cent
Manganese, not more than .000 per cent
Silicon, not more than .000 per cent

When drawn, these bands shall have a tensile strength not less than 48,000 lbs. per sq. in.; an elastic limit not less than 32,000 lbs. per sq. in.; an elongation not less than 35 per cent; and a ductility that will permit the bands to be spliced by twisting into standard telegraph wire splices without sign of fracture in the metal which shall be homogeneous in composition, structure, ductility and strength.

STAPLES AND LUGS:—All staples and lugs used to fasten the bands on the pipe shall be made of the quality of iron above specified for bands.

GAGE:—Five sizes of bands shall be used as follows:

No. 1, Diam. .285 inch
No. 2, Diam. .265 inch
No. 3, Diam. .245 inch
No. 4, Diam. .225 inch
No. 5, Diam. .205 inch

Staples shall be 1 in. long and shall be made of No. 8 wire.

Lugs shall be made of 3-16 in. iron with two spikes on the bottom 1 in. long and two side ears projecting 3-4 in. above the seat. The width of the lug seat shall be equal to three diameters of the band. The point of the staples and spikes shall be turned to cut across the grain of the wood to avoid splitting the staves. Lugs shall be cut and stamped to required form.

GALVANIZING:—All bands, staples and lugs shall be galvanized by pure zinc thoroughly applied in a uniform and adhesive coat of a weight of two oz. per sq. ft. of covered surface. The iron shall be free of dirt, grease, rust, scale and all other foreign matter. Acids used in the cleaning and preparatory process shall be neutralized so as to prevent corrosion by them under the zinc. The entire process of galvanizing shall be faithfully and completely executed under the supervision of a chemist experienced in galvanizing.

If a galvanized sample shows removal of zinc or a copper colored deposit after four one-minute immersions in copper sulphate, each followed by washing in water, the lot of galvanized wire from which the sample was cut shall be rejected.

The copper sulphate solution shall consist of 34.5 parts of copper sulphate in 100 parts of water and it shall have a specific gravity of 1.185 at 70 deg. Fahr. When used for testing, the solution shall have a temperature between 60 deg. and 70 deg. Fahr.

WINDING:—The band shall be spirally wound with uniform pitch on the pipe from end to end, spigots excluded, by a winding machine and under

each bar shall break under a concentrated center load of not less than 1800 lbs., and shall show a deflection not less than .30 in. before breaking.

All sleeves shall be uniformly sound and shall have clean, true and smooth surfaces. They shall be cleaned of burrs and foreign matter.

Each sleeve shall be six in. long with a shell ½ in. thick. The inside edges of the ends of the sleeves shall be rounded on a radius of ⅛ in. The entire interior surfaces shall conform throughout exactly to true circles having the following diameters:

For 6 in. pipe, the interior diameter of sleeve shall be 7⅞ in.
For 6¾ in. pipe, the interior diameter of sleeve shall be 8⅝ in.
For 7½ in. pipe, the interior diameter of sleeve shall be 9⅜ in.
For 8½ in. pipe, the interior diameter of sleeve shall be 10⅜ in.
For 9 in. pipe, the interior diameter of sleeve shall be 10⅞ in.
For 10½ in. pipe, the interior diameter of sleeve shall be 12⅜ in.
For 12 in. pipe, the interior diameter of sleeve shall be 13⅞ in.

A variation of 3-64 in. from the interior diameters above specified shall cause the rejection of the sleeve. Each sleeve shall be checked by a template for correctness and uniformity of interior diameter.

LENGTHS:—The minimum length of any pipe sections shall be not less than eight ft. The average length of all sections shall be not less than 12 ft.

COATING:—All pipe and all cast iron sleeves shall be coated by refined asphalt or coal tar. The pipe shall be turned on asphalt rolls until it has taken all the coating that it will carry, spigots excepted. It shall then be rolled on a saw dust table until the coating has become covered with a solid covering of saw dust. The flow point and the temperature of the asphalt or tar shall be regulated to secure a heavy, uniform and tenacious covering which, when hardened, will not flow under prevailing temperatures during manufacture and shipment. The spigots and the interior of the pipe shall be kept free of this coating.

B. J. MUSTAIN,
E. S. HUME,
D. BURKE,
E. R. FLOREN,
W. C. DALE,

Committee.

DISCUSSION

The President:—We will be very glad to have a discussion of this subject by any member. This is one of the problems that a great many railroads have to deal with and the water supply is a very important matter to them.

Mr. Knowles:—We have no pipe lines over four or five miles long. I am interested in the discussion of the wood stave pipe, because our experience with this is exactly opposite that outlined in the report. I have a line of wood stave pipe about three and one-half miles long on which I think I have spent about $800 in repairs. Much of the data on wood stave pipes has been collected on pipe which our forefathers made when they used the entire log. The log was bored out, turned off on the outside, wound spirally with bands and coated with pitch. In that way,

they removed the sap and the heart, and left only the best timber, but today we are using staves made from the entire log, sap, heart and good timber also. In making the wood stave pipe, we are also using a steel band where they used a wrought iron band and are coating it with so-called asphalt, often coal tar from which all the preservative has been removed. I notice also that the report states the pipes should be heated before the asphalt is applied. I do not understand how it would be possible to heat a wood stave pipe to a sufficient heat to make that application, unless in short sections. It reads as follows: "A satisfactory method is to dip the pipe in asphalt at the proper temperature, the pipe also being heated."

Mr. A. S. Markley:—I think that referred to iron pipe.

The Secretary:—As I understand it, the wood pipe is only heated sufficiently to receive this coating in the best way. It is not supposed to be made hot, but only heated so that this coat will take effect, and to insure that the pipe will not be so cold as to chill the asphalt before the wood becomes impregnated.

Mr. Knowles:—We have many members here from the West who probably have had a good deal of experience with wood stave pipe and I should like to hear what their experience has been. Mine has been bitter.

Mr. J. H. Markley:—When the water works were first built at El Paso, and Washington, Ill., wood pipe wrapped with wire and coated with asphalt was used. In six to ten years they had to commence taking it out and today it is all out. Personally I have not had much experience with wood pipes.

Mr. Knowles:—South Elmhurst, just outside of Chicago, also had a wood stave pipe line a number of years ago which has been removed.

The President:—We would like to hear more about these different classes of pipe lines, especially from the western people; I am sure they have had experience in this line of work.

Mr. A. H. King:—We are now laying some wood pipe line, and we have laid some with pretty good results, but none has been laid long enough for us to have had any failure. The rule that I would follow in recommending its use would be to lay it in places where it was generally moist,—where the wood can be kept wet on the outside of the pipe. What little experience I have had with it would indicate that if laid on dry ground, it will rot out in a few years. If submerged in water or in wet ground, I think

it would, perhaps, be preferable on account of chemical decomposition that might affect iron pipes.

Mr. Knowles:—I don't want to say everything bad against the wood pipe, because I know of some cases, Valparaiso, Indiana, for instance, where the city has had a 12-in. pipe line in use for 20 years. That, however, was made from solid logs and it has worked out very satisfactorily. My objection is that we are not getting the quality of wood we got in the old days but we are getting a different kind of pipe. There are doubtless places where we have a uniform pressure and soil conditions are right, where it would be advisable to use wood because it is 25 to 40 per cent cheaper in first cost and about as much cheaper to install.

Mr. J. J. Taylor:—We have two wood stave pipe discharge lines of about two or three miles each which have been in service about three or four years. I am sorry to say that this pipe has proven very unsatisfactory. The cost of maintenance has been excessive. We have been unable to hold it together at the joints, and we have had several instances where it blew out through the staves. I cannot recommend the wood stave pipe and don't think it will compare at all with cast iron.

The President:—Under what pressure is this pipe used?

Mr. Taylor:—I would say the pressure was about 75 pounds and sometimes probably as high as 100 lbs. We do not have a very high pressure where we use it.

Mr. Knowles:—That is a point I didn't mention. On the particular pipe line I referred to I believe this is largely responsible for the condition of the pipe. We have a static pressure from the city mains and city stand pipe of 40 lbs., but in case of fire that pressure is increased to 95 or 100 lbs. That is what I believe causes the trouble with the wood stave pipe, because naturally there is an expansion and contraction of the staves that works it loose and allows the water to ooze in under the bands and the asphalt coating, leaving the bands bare. If these bands are made of steel, you can readily see what will happen as far as corrosion is concerned.

The President:—I saw a wooden pipe at the office of the city engineer in Jersey City which was made out of a log. I don't recall the year, but I dare say it was under the ground about 70 years and it was still in good condition.

Mr. Alexander:—We have had no such long pipe lines as have been spoken of here, or any wood pipes; but I presume this

subject is not confined altogether to wood or iron of any particular kind. We have perhaps 5,000 or 6,000 ft. of wrought iron pipe which had been dipped in asphalt originally, the pipe being heated before dipping, so that it was thoroughly coated both inside and out. It seemed to be necessary to hang this pipe line up under a wharf—it was for the water supply for vessels—so that it would be clear of the water but out of the way of the traffic above. Plugs descended at various places where we could attach and get water. The pressure was about 125 lbs. per sq. in. at that point. We found in five years that this pipe had corroded through the paint outside so one could stick a knife through it in places and it began to leak so that we had to tear it out. We found that pipe which was placed on top of the wharf lasted a great deal longer, so we renewed that pipe with wrought iron, boxed it and laid it along the front of the wharf, back of the timber, where it was covered so as not to be in the way of construction. We tried to get what was recommended as wrought iron, not steel.

We have found, in the ground where we have a great deal of so-called wrought iron pipe, that in some places it lasts indefinitely,—especially in wet ground. It has been said here that iron pipe lasts indefinitely in wet ground while it will rust out largely in dry ground. This is what we found underneath the wharf. Where the spray continually kept at the pipe it would rust out and scales would form a quarter of an inch thick. While these scales adhered to the pipe, the iron would waste away until the pipe was eaten through; we find that both in pipe lines and tank hoops, there is a great difference between metals. With us some tank hoops last for 25 years and are still good, while others give way and fall off the tank in six years. It must be the difference in the metal, for there is no difference in the climate.

Mr. Staten:—On the C. & O. we had an old wood pipe line that was made by hand. We cut down the saplings and bored a three-inch hole with an auger which was fitted into a wooden handle, two men doing the work. The bark was not even removed from the poles. The hole was enlarged a little in one end so as to receive the end of another which was tapered down with a drawing-knife. The length of this line was about 5,000 ft. I do not know how long it was in use, but it was there a long time. Only a short time ago I saw a piece of it that had been unearthed in putting in a pit.

Mr. A. S. Markley:—That was a gravity line, was it not?

Mr. Staten:—Yes, a gravity line off the Alleghany mountains, I will ask Mr. Vandegrift if he can tell us how long that wood pipe was in there.

Mr. Vandegrift:—It was there 25 or 30 years. The sections were cut in 10 ft. to 16 ft. lengths. Some were so crooked they had to be bored from both ends.

Mr. A. S. Markley:—Is that pipe line still in service?

Mr. Staten:—No, the tank was removed for the reason that there was not sufficient water to supply the demand, and when the tank was removed the pipe line was abandoned.

Mr. Ewart:—We have a few long cast iron and wrought iron pipe lines on the Boston & Maine. There is one trouble we have which I have not heard spoken of here; I do not suppose that it causes much trouble in the country, but we are bothered a great deal with electrolysis on our cast iron lines. A leak was reported to me the other day. I sent the men there to dig it up, and to repair it, and they found, when they got down to the pipe, that they could whittle it with a knife. It wouldn't hold any pressure. If struck in one place the pipe would break off and on the other hand, in other places it was all right. I laid that pipe line myself about 25 years ago. Electrolysis is the great trouble in the neighborhood of Boston. All the city water lines. have the same trouble. Four years ago I renewed a line replacing about 4,000 feet of eight-inch and six-inch pipe with twelve-inch. The pipe I took out was eaten all the way through by electrolysis. Until one gets at it, he can not tell anything about it. It may look all right, but it may go to pieces. It seems to be eaten away as though something had been wearing on it. Nobody has yet found any way to overcome it, and I believe it limits the life of our cast iron lines. We have a lot of wrought iron pipe, and in ordering we always specify genuine wrought iron pipe. This costs us considerably more than steel pipe, but it pays to put it in. We have places where we can put steel pipe in the ground and almost see it disappear. It will not last. I have taken steel pipe out that had not been in a year. I think wrought iron is preferable on the ground of economy. We have thousands of feet that are laid out in the open. When we lay it on a bridge, as Mr. Alexander has spoken of, my plan is to lay it in a hard pine box constructed of two-in. material. We are laying a three-inch pipe for water supply. We put it in a two-inch hard pine

box about 12 inches square, centering the pipe as nearly as possible in the box, filling the box with "spent" tan bark and then making it as tight as possible on top. That construction will withstand a considerable amount of freezing and I think it has a tendency to preserve the pipe. We find that galvanized iron pipe (although that is poor enough) will stand better than the common iron. We never have used asphalt or tar. We either use the plain or galvanized pipe, but no matter what we put in, we have troubles enough. I suppose the elimination of danger from electrolysis would be one thing in favor of the wood pipe. Electrolysis would never hurt that, but we never have had any of it.

Mr. Staten:—There is a big foundry at Lynchburg, Va., that makes iron pipe of all sizes. The city of Lynchburg gets its water supply about 16 miles away, and the wood pipe for this was shipped from California. I have seen four or five car loads of that pipe on the side track there, and on another side track as many more cars of cast iron pipe billed to California. There must be a good reason for shipping this iron pipe to a country where they manufacture wood pipe or else their wood pipe does not give satisfaction in that country.

Mr. Killam:—We have no very long pipe lines on the Intercolonial Railway, the longest being probably four miles. We have always laid cast iron pipe with the joints caulked with lead, and for the last 13 years or more, we have never known a pipe to give out. Our pipe lines are all of cast iron pipe with lead joints, or wood backed up with lead, and put down below the surface. In some places, where necessary, they come to the top, but they have never given out. At one time I built a line of railway 45 miles long where we had short pipe lines except in one place, the longest one consisting of 4,000 ft. of wooden pipe line. I used 10-ft. sections of timber, not less than 8 in. through at the top, and the bark was all left on, taking the timber in its natural state as it came out of the woods. It was all fitted together with a machine that drove one section into the other. Each joint was saturated with Stockholm or American tar and the big end of the tree was banded with Swedish iron. This pipe line stood until we abandoned the tank system at that place 12 years later and we never had a leak. In making the pipe, we ran a piece of hot iron through each joint to do away with the friction. It was also claimed at that time that searing the inside of the wood acted as

a preservative, taking the sap out of it. It withstood a pressure of about 35 ft. head from the spring to where it came into the tank.

Mr. Robinson:—In 1893 we laid two miles of cast iron pipe in our shop grounds at Chicago and covered it with sand and cinders. In 1899 we found it completely gone, took it out and laid about five miles of 6-in. to 12-in. pipe, covering it with blue clay. Up to the present time it is perfectly preserved.

Mr. Warcup:—I agree with Mr. Robinson in regard to keeping cinders away from the pipe. It is necessary to have a protection of clay or sand to keep the cinders away, or the pipe will rust through. Also, in regard to electricity in water-mains, an incident happened not very long ago, at a standpipe at Chatham; the street car line is about 200 ft. from the standpipe, and we couldn't find out why this pipe was electrified, but finally discovered that the rails of the street car track were connected by a ground wire to the pipe so that when a man was on the tender taking water, he got a shock. Also, in another instance some telegraph batteries were attached to a wrought iron pipe, and that pipe was completely pitted on the top. On the Grand Trunk we use principally galvanized iron pipe for small pipe from 2½ in. down to ¾ of an inch; above that size we use cast iron.

Mr. Knowles:—I am glad to hear this discussion of the protection of pipe lines, because I think that it is a very important subject and is something I have had to contend with. One gentleman spoke in regard to lines laid along the wharf. I had a similar experience with 6-in. wrought iron pipe with 4-in. risers, laid along our Stuyvesant docks at New Orleans. We found it necessary to renew that pipe line, in fact we are renewing it now, after a service of five to six years. That pipe was dipped in something supposed to be asphalt, and we found it corroded rapidly. We are now putting a wrought iron pipe in on the other side of the wharf and we have an analysis made of a section of this pipe to see that it does comply with the requirements for wrought iron pipe.

I have also had some experience with electrolysis at Paducah, Ky. There is no doubt that much of our electrolysis is caused from ground wires attached to the pipes, but there is a great deal also coming from places where the pipe line lies between two power transmission lines. This is going to get more serious every day as power transmission lines increase in number. In this instance we had a street railway line on the west and a

mechanical coal chute on the east with a high power transmission line to the chute and a 6-in. line, perhaps 600 ft. long, between the two. The current seemed to jump from the street car line and follow the 6-in. pipe line to the coal chute, where it would leave the pipe, leaving a hole, as Mr. Ewart says. I do not know that there is any method for preventing electrolysis; if there is, I never heard of it. It might be possible for us to connect up on the other end and transmit power, too, but I don't think the power companies would stand for that.

Mr. Warcup:—Electrolysis is more serious than most of us are willing to admit. We have a number of miles of Pintsch gas pipe lines, on which we had occasion a while ago to make some repairs. The gas was drawn back and as soon as we broke the joint the thing instantly took fire. It frightened the men working on it and they did not know what to make of it, but it was caused by the electricity running down the pipe, igniting the gas at the break in the pipe. This was on a bridge, and I suppose the electricity was running for the water which it would have reached if it had gone a little further. Now, when we have occasion to break a pipe on the bridge, we always wind a piece of copper wire on one side, then connect it on the other side and carry the electricity beyond us. That is the only way we can handle it.

We have also had our troubles with cinders so that now, in laying either cast iron or wrought iron pipe through cinders, we take the cinders out below the pipe and fill in with sand or gravel for a foot above the pipe before we let the cinders in. I have cases where we have lead services and we have been obliged to do the same thing, as they will eat a lead pipe out in two or three years.

Mr. Robinson:—Some kinds of sand are also injurious to cast iron pipe. We have a pipe line about three miles long that has broken in places and we found that pitting caused it. We never found any electrolysis on it, although there are several electric lines in the vicinity.

Mr. Alexander:—We have frost in our country that often goes to the depth of six feet. That is as low as we lay pipe and sometimes a small pipe will freeze. To protect it from the frost, I have often laid a V-shaped wooden box inverted over the pipe to keep the frost from striking it, leaving an air space along the pipe as it was filled. In some instances we make a square box

and case it in thoroughly. The question occurred to me whether boxing a pipe would keep the different materials away that would destroy the pipe in case of electrolysis. It might be a good suggestion to try this and fill the box with some material that would preserve the pipe and perhaps prevent electrolysis.

Mr. Clark:—The troubles with pipe lines appear to be local; I think every section of the country has its disadvantages. We have some disadvantages in Western Pennsylvania, that I have not heard anyone speak of. I refer to the effect of mine water on pipes. On my last inspection I found one 30-in. sewer pipe under the track which had been in only a very few years entirely eaten away by mine water. On some parts of the road, especially along the Allegheny River, the sand apparently eats the pipe out almost as quickly as cinders. We all know that the cinder is a deadly enemy of pipes, and in cinders, we either box the pipe, or else excavate and get clay, put down a bed of clay, lay the pipe in it and cover it over. We find that does very well. On some of our lines where we have interlocked switches operated by air, we have places where we carry the air from one to two miles. In such places we put the pipe line in a box and then fill the box entirely full with pitch and cover it up, practically hermetically sealing the pipe. The remedy for all these things must be found to suit the conditions. We all know that there are places where a tile pipe will outlast a cast iron pipe.

Mr. Dupree:—We all know that mine water contains sulphuric acid, which destroys pipes. One gentleman spoke about putting a little sand over the pipe, then cinders over the sand, which is wrong, because the acid from the cinders will penetrate that sand and attack the pipe. The best way to prevent this is to put a covering over the pipe as Mr. Robinson said, of blue clay or other material of that nature, wrap the pipe with some kind of mineral roofing, then put cinders or other material at hand, over it, so as to shed any acids off the pipe.

Now, in regard to galvanized pipe; it usually is good, but the manufacturers sometimes make galvanized pipe of inferior quality, then cover it over, and the galvanizing preserves it. We should be cautious when we put galvanized pipe together for on the end where the threads are, ⅛ inch of the metal is gone, and the couplings should be made strong enough and long enough to cover all the metal that was galvanized and is cut

away. It is the same way with the black pipe. We should cover the couplings and protect the threads.

Mr. Knowles:—In covering an underground pipe, I am of the opinion that in some cases it would be necessary to spend as much and in many cases more, to get the proper covering as to put the pipe in, and if one puts a pipe under ground and the soil conditions are not right it is hard to protect it. Clay is all right but in many cases one is working in soil where he can find no clay. If one put sand around the pipe and cinders over the sand, as Mr. Dupree says, the sand is not much protection against cinders or mine water. It might act as a detriment because it might concentrate the action of the acid on the pipe and cause it to become more vigorous in its action. In regard to covering it, I do not think one can put on a satisfactory covering without its becoming more expensivve than the pipe itself. One would have to use tile or something of that sort, and he would have a dead air space around the pipe, but that would cost more than the pipe line. I think a covering is out of the question for an ordinary cast iron pipe line or any underground pipe. The best protection for a pipe line is either to lay wrought iron and be sure that you get wrought iron, or to lay a cast iron pipe and keep injurious filling from coming in contact with it.

Mr. A. S. Markley:—We have our troubles on the inside of the pipes as well as the outside; I would like to know if there is any remedy for that? Another thing our subject covers is tanks. We have our troubles there, too, with mud flowing into the well and filling it up.

Mr. J. H. Markley:—We have two large reservoirs where we take water from a suction pipe that runs into them. In both cases I have built wooden sumps made about 6 ft. square and always take the water down over those sumps. I have never had any occasion to clean them out and never have any trouble at all with them.

Mr. A. S. Markley:—That would apply to ponds, but we have streams where we can't do that; we've got to take water from the streams.

Mr. J. H. Markley:—We have a case of that kind also. We have a pipe running out into Spring river, which is about as muddy a stream as one will find, being fed mostly from prairie farms. The pipe leading out into the stream is an 8-in. pipe, and on the end I have placed a valve that is opened when the man

begins to pump, and is closed when he gets through. We have very little trouble with mud.

Mr. Knowles:—I think Mr. Markley's point is well taken. We ought to consider the inside of this pipe as well as the outside. We have many stations on the Western lines through Iowa where we have the same trouble with sand and silt coming down. We construct a wood or concrete sump depending on the material we have handy. If we have bridge timbers, we construct it of that material which answers very well with an intake in a river. We clean it out, but at certain places every year we have trouble with leaves and rubbish of that sort which is hard to get at, because it usually comes down during the flood period when one cannot get at his pipe line. In such cases we have had great success with multiple strainers. One can secure them in one, two, three or four chambers. Two are enough for ordinary conditions. They are located in the pump house next to the pump. The end of the pipe is left open and anything that will pass through the pipe is caught in the strainers. It is not necessary to stop the pump while the strainer is being cleaned as one side can be shut off while the other is being operated. We have them in our 26th Street station, Chicago, where we have trouble with rubbish and small minnows getting into the pipe. I have seen barrels of these minnows and stale hops from a nearby brewery get into the suction pipe. This is the most successful method of keeping the suction pipe clean. Of course, where one has a large amount of sand this would not do any good, as the sand will fill the suction pipe. Referring to incrustation inside of the pipe,—we have had some experience with that,—but it has not been from our treating plants. The Big Muddy pipe line is about four miles long, three miles of which is 8-in. cast iron pipe and one mile 12-in. That line was laid about 1903, and in 1908 the pressure went up until it was necessary to carry 140 lbs. to deliver a million gallons a day, which indicated that it was partly clogged up, so we had it cleaned.

Mr. A. S. Markley:—We make our intakes 300 to 400 ft. in length, or less where conditions will permit, through which the water flows by gravity from the stream into a well. The well answers the double purpose of reducing the temperature of the water in cold weather and permits the sediment to settle before the water enters the pumps. The intakes should be no larger than necessary to supply the pump; this causes sufficient cur-

rent to keep the passage clear of sediment. The well must be cleaned out occasionally to remove sediment which has collected.

We have 13 treating plants of both types,—intermittent and continuous, all of which use the same ingredients,—soda ash and lime. At our Oaklawn shops at Danville, Ill., we have the continuous process which was installed in 1905 or 1906. The power house is located some 450 ft. from the treating plant, which has a 3-in. supply pipe for the boilers and this has become so clogged with incrusting matter that we shall have to replace it and then we will take up the old pipe and try to clean it out. We have been informed that it is impractical to remove this incrusting matter while the line is in service. At our intermittent plants we experience trouble with inspirators and their connections in becoming clogged. Brass seems to collect incrusting matter more readily than iron.

Storm sewers at Oaklawn are being affected by reason of the sediment from the treating plants and it is getting to be a serious matter. The sediment is so hard that it is almost impossible to remove it with sharp pointed tools. If any of our members will inform me how to remove this sediment it will be appreciated.

Mr. Dupree:—I think I can answer Mr. Markley in regard to his treating plants, as I am slightly acquainted with them, since I built six of them myself. I built the Oaklawn plant and I know the conditions thoroughly. If Mr. Markley will allow the water to settle longer, clean out the tanks properly and not blow the sediment from the 80-ft. stand pipe into a sump, but draw the water off the top and haul away the sediment and not permit it to get into the sewers it will save all of that trouble. "An ounce of prevention is worth a pound of cure," and pipes, sewers and drains should receive careful attention where sediment is found.

Mr. A. S. Markley:—We try to be as careful as possible in that respect. At Oaklawn the sludge is run out through a surface sewer with no settling basin. At other places where we have intermittent plants we make use of settling basins, from which the sludge is hauled away by teams; but even with these precautions so much sludge and sediment gets into the ditches and drains as to cause criticism on the part of the authorities, and we have been refused the use of drainage ditches until the matter is remedied.

At our Oaklawn plant the treated water flows by gravity from the top of the 70-ft. treating reservoir into the storage tank,

but in this process it is not possible to remove more than 40 to 50 per cent of the sediment where such a large quantity of water is used.

Mr. Clark:—We aim to take the water from the downstream side, where we put an intake in a stream in order to allow sediment and rubbish to flow past as far as possible, so that no material will catch and flow in other than as the natural suction of the water carries it into the sump. In several instances we have a row of 4-in. or 6-in. pipes along the lower side, maybe 15 or 20 of them, to allow the water to flow in slowly, so as not to draw in any more sediment than can be avoided. Then, the floor of the sump or intake box is a certain distance below the intake pipe to give the sediment that has entered a chance to settle. It is then cleaned out, which necessarily must be done by hand. In regard to the softening plant: we make it our practice to change the excelsior and clean the tanks once every six months, as far as possible. We allow the sediment to settle and then clean the tank out thoroughly. We have a manhole on the side of the tank and the sediment is all thrown through that and disposed of; in that way none of it goes into the sewers. The matter of connecting to a sewer to save a little money came up some time ago, but was disallowed because of just what Mr. Markley is talking about,—liability to close up our sewer system. I don't think there is any way that one can prevent all matter from getting into the intake pipe or into the intake box, but the only thing is to fix it so that as little as possible will get in and then arrange so that what little does get in can be taken out by hand.

Mr. A. S. Markley:—We follow the plan suggested by Mr. Clark, of course, but we are continually pumping out of the well and the current in the well brings up the material. We have just finished a well 16 ft. in diameter, placing the bottom of it 4½ ft. below the stream and topping it with concrete, so we have no trouble in that direction, but we get mud in just the same.

Mr. Clark:—The idea of putting so many of these small pipes in is to allow the water to flow very freely into the intake box, so that neither the pumping out of it nor the force of the flowing in, will keep the sediment stirred up. The idea is to keep the water in there as quiet as possible, to allow more of the sediment to settle.

Mr. Knowles:—I don't think we will ever succeed in keep-

ing mud out of our intake boxes. The only think we can do is, as Mr. Clark said, to reduce it to a minimum and clean it out occasionally. The sand is in the water and as long as we continue to pump during flood stages we are going to get it. We might have a series of intake boxes and bring the water through three or four of them. In that way we could eliminate the sand, but the scheme is impracticable. I have tried it in a number of cases where the sand was coarse, but it would not do in a sandy loam. Where the sand was very coarse, I have used old, discarded well screens, 20 ft. long, putting them in a sandy bed of a river; they will work all right except where the water is very muddy, when the sand becomes impregnated with mud and the water will not go through. I have used this method successfully in a number of cases in the South.

Mr. Elliott:—We have one place where we supply a village with water suitable for domestic use and also supply our shops and locomotives. In digging the reservoir near the river we struck quicksand a little below the bed of the river and could not go much deeper. We went as low as we could, however, and put in a wooden box which came above the sand perhaps two or three feet and yet was below the surface of the water. We filled around outside of the reservoir with broken stone, and made a large intake which extended from the reservoir to the river which was below the water all the time and provided a sluggish flow to the filter. The foot valve is at the bottom of the box, and no sand can get to it. The sand does not rise above the top of the box but the water flows over it all right and in that way the sand is excluded from the foot valve.

Subject No. 9.

DEVELOPMENT OF TURNTABLES TO MEET OPERATING CONDITIONS FOR THE MODERN LOCOMOTIVE, SHOWING THE BEST IMPROVED PRACTICE.

REPORT OF COMMITTEE.

Your committee takes pleasure in presenting a complete report. Under other conditions an apology for the length of the report might be in order, but in view of the length of the title assigned to the subject by the president, the length of the report appears justified. On account of its length, however, the committee did not feel justified in adding another chapter on the history of the subject.

A circular letter was prepared and sent to about 60 railroads with the expectation that perhaps one-half of that number would respond. After a month had elapsed tracers were sent out, and at the end of three months replies had been received from 57 roads, aggregating 175,000 miles of line. The information with reference to features in which practice varies widely was tabulated under the following eight headings:

Length of standard table.
Type of standard table.
Loading and unit stresses.
Locks for holding rails in line.
Power for turning.
Means to fasten rails to parapet and circle wall.
Approximate cost.
Centers.

The tabulation accompanies this report.

After the tabulation had been prepared the Committee held a meeting at the Missouri Athletic Club, St. Louis, Mo., June 25th, and spent the entire day in the study and discussion of the information at hand. At this meeting there were present C. E. Smith, Chairman, J. S. Berry, A. S. Markley and C. H. Fake. Mr. F. G. Jonah was absent.

The Committee concluded that the information furnished by the roads was unusually full and complete, and indicated tremendous interest in the subject all over the country. We feel deeply indebted to all the roads that took such unusual measures to respond fully, and especially desire to express our thanks to Mr. A. Montzheimer, chief engineer, Elgin, Joliet & Eastern, for his complete information on the subject and particularly for the information he furnishes relative to the so-called non-tipping tables; also to Mr. A. F. Robinson, bridge engineer, Atchison, Topeka and Santa Fe system, who furnished the Committee enough information to make a complete report on the subject.

The Committee's discussion of the subjects treated under the eight headings mentioned above, and of a number of other features that were discussed, together with a brief synopsis of the information secured and its recommendations where such were considered advisable, are given in the following pages.

Standard Length.

STATEMENT SHOWING STANDARD LENGTHS OF TURNTABLES USED BY VARIOUS ROADS.

75 ft.	80 ft.	85 ft.	90 ft.	100 ft.
B. & M.	B. & O.	A. T. & S. F.	B. R. & P.	C. & O.
C. & E. I.	B. & L. E.	B. & A.	C. & A.	N. & W.
C. R. I. & P.	B. R. & P.	C. & O.	C. G. W.	
I. R. of Can.	C. of Ga.	C. M. & P. S.	C. M. & St. P.	
I. & G. N.	C. R. R. of N. J	C. C. C. & St. L.	C. St. P. M. & O	
Mo. Pac.	C. & N. W.	I. C.	D. & H.	
M. & O.	C. B. & Q.	L. S. & M. S.	K. C. S.	
Nat. Rys. of Mex	C. I. & L.	L. & N.	N. C. & St. L.	
N. Y. N. H. & H.	C. & S.	N. Y. C. & H. R.	P. & L. E.	
P. & R.	D. & R. G.	N. P.	Southern	
St. L. & S. F.	E. J. & E.	Pennsylvania		
Wabash	Erie	Pa. Lines West		
	G. T.	S. A. L.		
	G. N.			
	L. V.			
	Long Island			
	Maine Cent.			
	O. S. L.			
	U. P.			

B. & O. uses 100-ft. tables with end carriages for Mallets. Grand Trunk has one 100 ft. table to accommodate large house. O. S. L has 100 ft. table for Mallets. P. R. R. has one 100 ft. table to avoid frogs. U. P. has some 100 ft. tables for Mallets.

Special lengths used or under consideration by above roads.

M. & O. expects to increase standard to 80 ft.

B. & M. considering use of 80 ft. tables.

Nat. Rys. of Mex. uses 80 ft. tables for Mallets.

B. & O. uses heavy end carriages so 80 ft. tables need not balance.

N. Y. N. H. & H. has built some 80 ft. tables.

P. & R. has one 85 ft. table.

A. T. & S. F. has a few 90 ft. tables to avoid frogs.

D. & R. G. uses 90 ft. tables for Mallet engines.

C. R. I. & P. considering use of 90 ft. table.

St. L. & S. F. considering use of 90 ft. tables and may install some 100 ft. to 110 ft. for Mallets.

Great Northern has some 92 ft. tables for Mallets.

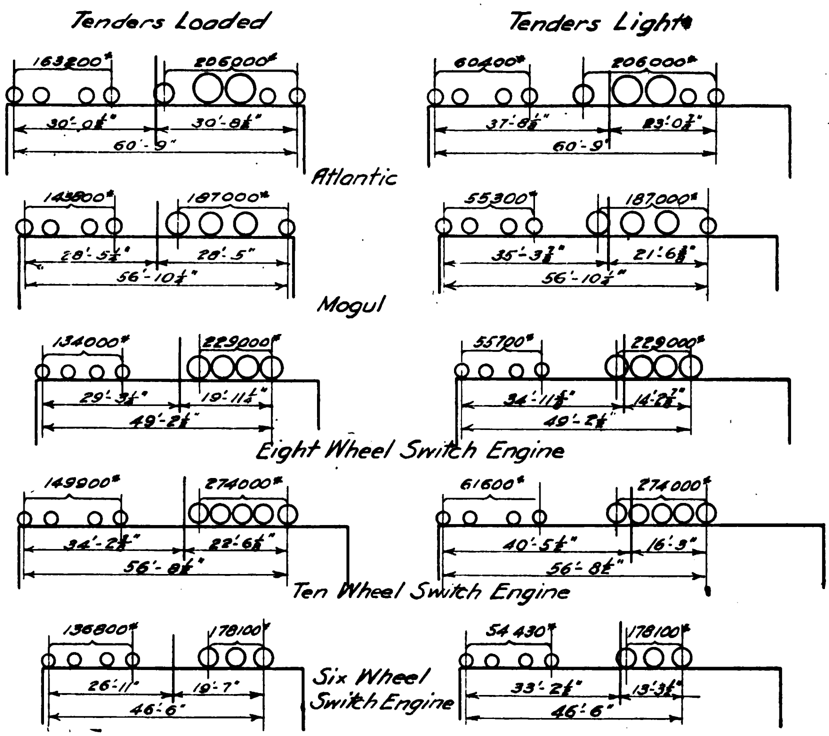
C. M. & P. S. has a few 105 ft. tables to turn Mallet engines.

Practically all roads report short tables in service on old lines but no road reported a standard length shorter than 75 ft. The standard lengths reported by various roads are as follows:

12 roads report standard length as 75 ft.
19 roads report standard length as 80 ft.
13 roads report standard length as 85 ft.
10 roads report standard length as 90 ft.
2 roads report standard length as 100 ft.

In addition several of the roads report the use of turntables longer than their standard for special purposes such as the turning of Mallet locomotives, the elimination of frogs in approach tracks, etc. The longest table reported in use is on the C. M. & P. S., and is a pony truss table 105 ft. long, weighing 175,000 lbs.

The necessity for a liberal allowance for future increase in length is shown by past experience. For some reason turntables have invariably been built only long enough for engines actually in use and frequent enlargement has been necessary. In this connection the Santa Fe reports: "In 1896 we commenced building 60 ft. tables. We used these about two years and then went to 75 ft. The 75 ft. length lasted less than one year when the new engines forced us up to 85 ft. tables."

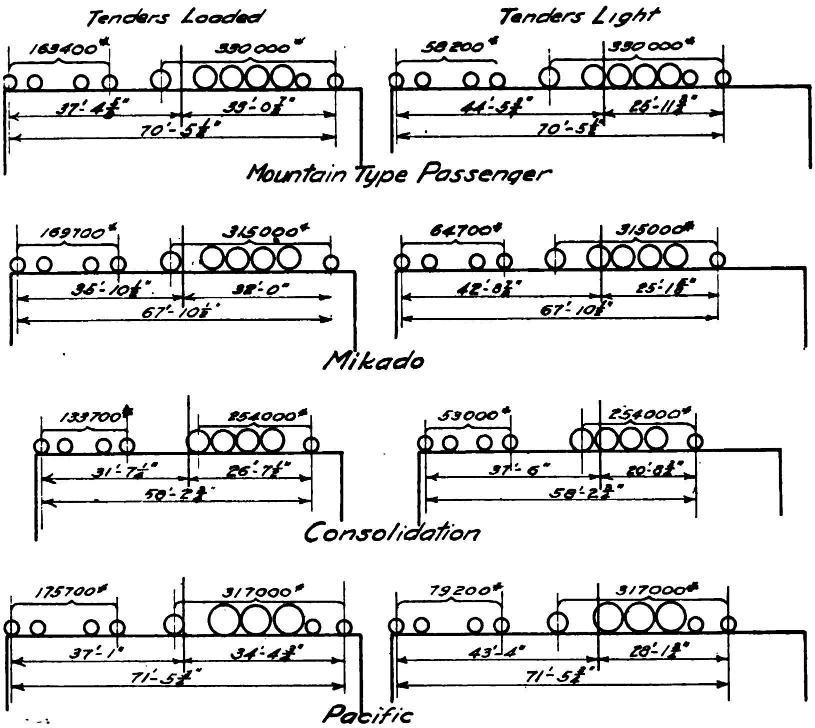


Diagrams showing location of center of gravity with reference to turntables of largest Atlantic, Mogul, 8-wheel switch, 10-wheel switch and 6-wheel switch locomotives, constructed by the American Locomotive Co.

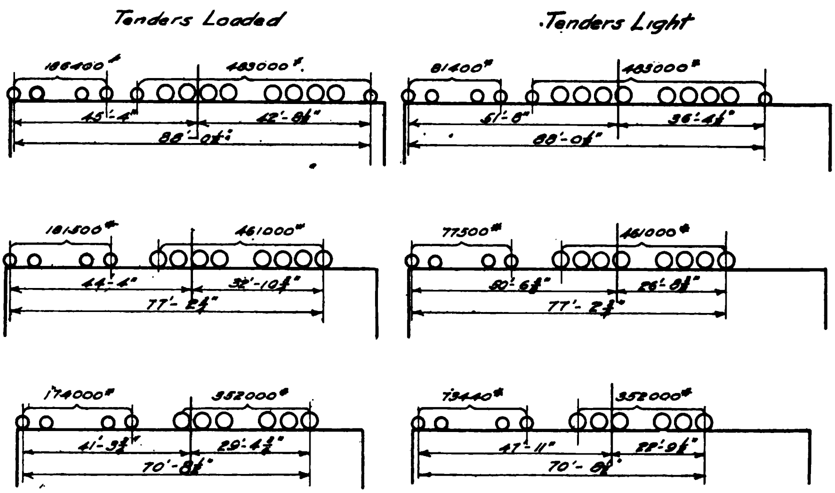
The locomotive diagrams accompanying the report show the weights, wheel bases and balancing conditions of the heaviest locomotives of 12 types manufactured by the American Locomotive Company, 6 types by the Baldwin Locomotive Works and the large Santa Fe 24 wheel Mallet compound engine. The statement showing wheelbase and balancing lengths of heavy locomotives prepared from these diagrams shows that a table 90 ft. long will balance all heavy engines under all conditions with the exception of Decapod and Mallet engines and will balance Decapod engines with part load on the tender. A table 90 ft. long is longer than the wheelbase of any locomotive, including the Mallet engines (with the exception of the 24 wheel Santa Fe Mallet) and will turn all but the Santa Fe Mallet, provided a heavy truck and motor are provided at one end to roll the unbalanced load that will rest on one end truck. Even for the largest Mallet engine (except the large Santa Fe engines) the weight on an end carriage will not exceed 50 tons. The success of such construction and operation is merely a matter of the design of the end carriages.

A number of roads are already using heavy end carriages to dispense with the necessity for balancing the locomotives. The Pennsylvania Lines West provide steel springs to reduce the shock on the end carriages.

A few roads have built tables from 90 to 105 ft. in length, several of the latter length, of the riveted pony truss design with standard steel stringers and floor beams, having been installed on the Chicago, Milwaukee and Puget Sound. The steel in the table weighs 175,000 lbs. and the entire installation probably cost from $15,000 to $20,000.



Diagrams showing location of center of gravity with reference to turntables of largest mountain type passenger, Mikado, Consolidation and Pacific locomotives, constructed by the American Locomotive Co.



Diagrams showing location of center of gravity with reference to turntables of largest Mallet compound locomotives, constructed by the American Locomotive Co.

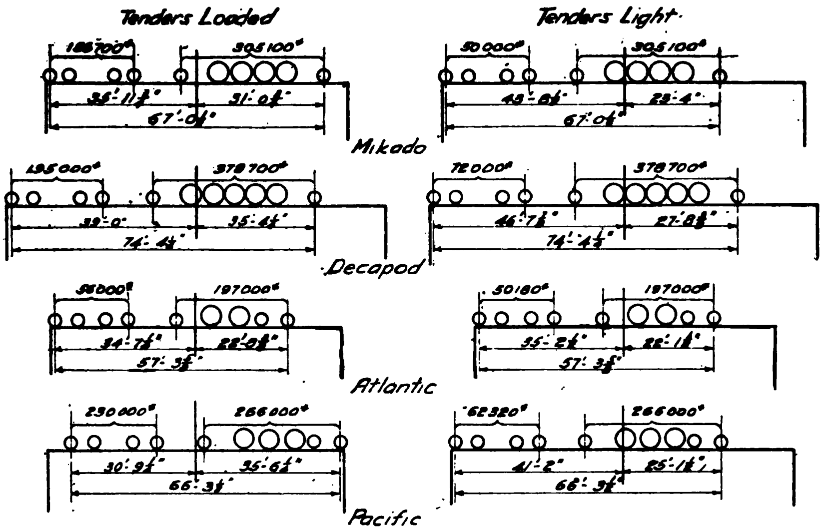
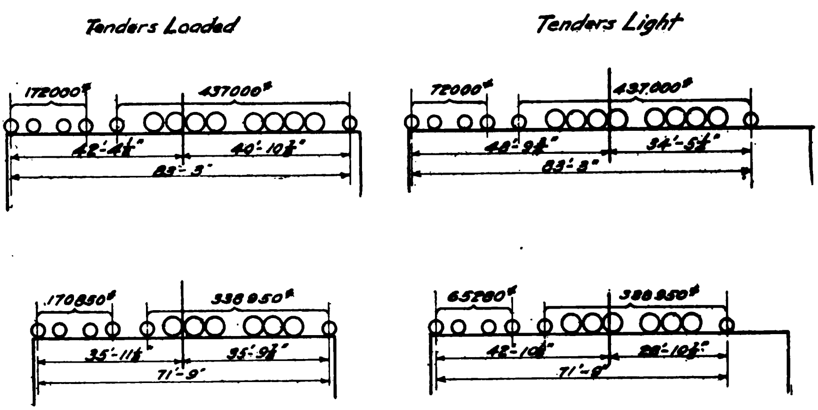
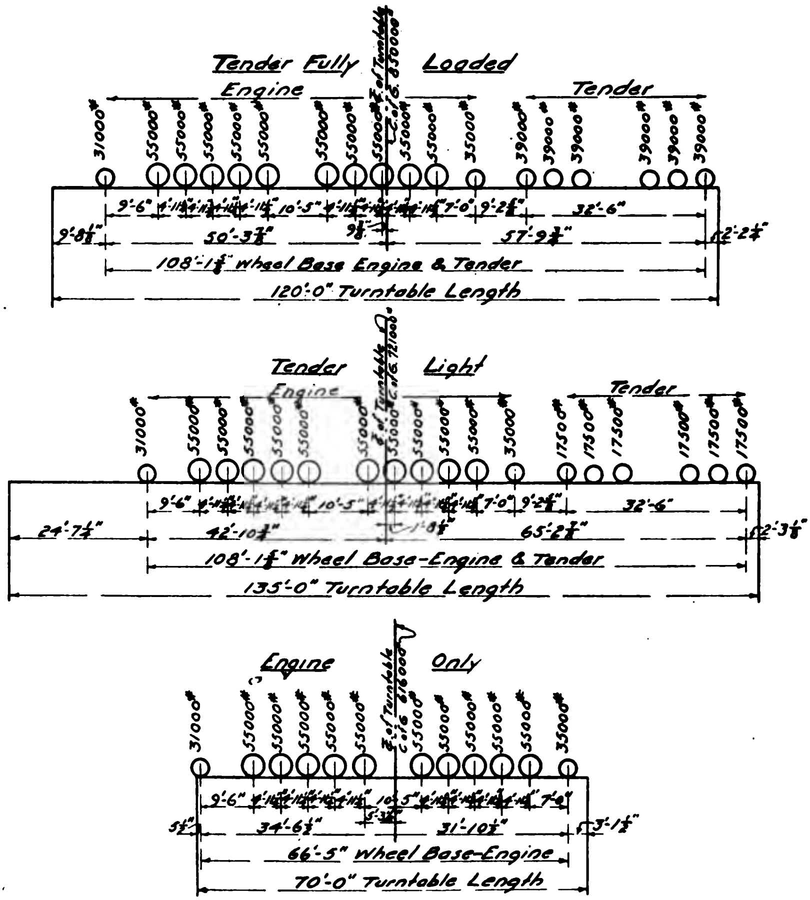


Diagram showing location of center of gravity with reference to turntables of largest Mikado, Decapod, Atlantic and Pacific type locomotives, constructed by the Baldwin Locomotive Works.



Diagrams showing location of center of gravity with reference to turntables of largest Mallet compound locomotives, constructed by the Baldwin Locomotive Works.



Diagrams Showing Turntables to accomodate A. T. & S. F. Ry Co's Mallet Compound Locomotive with and without Tender

Diagram showing length of turntable required to turn Santa Fe 24-wheel Mallet compound locomotive under various conditions.

The Santa Fe does not turn its long Mallet engines on a turntable. Mr. A. F. Robinson, bridge engineer of that system, says: "Not in favor of building extremely long turntables, that is, long enough to handle our double Mallet Santa Fe engine, a table which would have to be about 135 ft. in diameter. These can be built and operated successfully. The cost of repairs and operation, however, will, in the writer's judgment, be high." The cost of such a table would probably reach $25,000.

The Committee recommends that for standard gauge roads no future turntable be built shorter than 75 feet and that for roads that expect to use the heaviest engines, 90 ft. be adopted as standard.

For engines having wheel bases longer than 90 ft. wye tracks should be provided unless special local conditions compel the use and justify the expense of a longer table.

STATEMENT SHOWING WHEELBASE AND BALANCING LENGTHS OF HEAVY LOCOMOTIVES.

Type	Wheelbase	Required Length of Turntables with Tender Full	Required Length of Turntables with Tender Empty
AMERICAN LOCOMOTIVE COMPANY.			
Mountain type passenger,	70 ft. 5½ in.	76 ft. 0 in.	90 ft. 0 in.
Mikado,	67 ft. 10½ in.	73 ft. 0 in.	86 ft. 0 in.
Consolidation,	58 ft. 2¾ in.	64 ft. 0 in.	76 ft. 0 in.
Pacific	71 ft. 5¾ in.	75 ft. 0 in.	88 ft. 0 in.
Atlantic,	60 ft. 9 in.	62 ft. 0 in.	77 ft. 0 in.
Mogul,	56 ft. 10¼ in.	58 ft. 0 in.	72 ft. 0 in.
Eight wheel switch,	49 ft. 2½ in.	60 ft. 0 in.	71 ft. 0 in.
Ten wheel switch,	56 ft. 8½ in.	70 ft. 0 in.	82 ft. 0 in.
Six wheel switch,	46 ft. 6 in.	55 ft. 0 in.	68 ft. 0 in.
BALDWIN LOCOMOTIVE WORKS.			
Mikado,	67 ft. 0½ in.	73 ft. 0 in.	89 ft. 0 in.
Decapod,	74 ft. 4¼ in.	79 ft. 0 in.	94 ft. 0 in.
Atlantic,	57 ft. 3⅝ in.	70 ft. 0 in.	72 ft. 0 in.
Pacific,	66 ft. 3½ in.	72 ft. 0 in.	84 ft. 0 in.
MALLET COMPOUND ENGINES. AMERICAN LOCOMOTIVE COMPANY.			
2-8-8-2,	88 ft. 0½ in.	92 ft. 0 in.	105 ft. 0 in.
0-8-8-0,	77 ft. 2¾ in.	90 ft. 0 in.	102 ft. 0 in.
0-6-6-0,	70 ft. 8½ in.	84 ft. 0 in.	97 ft. 0 in.
BALDWIN LOCOMOTIVE WORKS.			
2-8-8-2,	83 ft. 3 in.	86 ft. 0 in.	99 ft. 0 in.
2-6-6-2,	71 ft. 9 in.	73 ft. 0 in.	87 ft. 0 in.

TYPE OF TABLE.

The deck plate girder type appears to be desired by all concerned, but through plate girders and pony trusses are extensively used where it is diffi-

cult or impossible to secure drainage for the deeper pits required for the deck types, especially for the longer tables. Thirty-one roads use deck plate girders exclusively. Fifteen roads use deck plate girders wherever possible and through plate girders where drainage conditions demand, one road having used a through plate girder to decrease the necessary amount of excavation, the pit being located in solid rock. Seven roads have found the drainage of deep deck pits such an unsatisfactory procedure that they have adopted the through plate girders as standard. Four roads using deck girders state they would use through girders if drainage conditions demanded. The N. C. & St. L. states it would go to great expense, say $3,000 or $4,000, to avoid through tables. The N. Y. C. & H. R. states that their turntable pit is always higher than the lowest point of the engine house drainage and therefore the choice of turntable is not ordinarily affected by the matter of drainage. The C. B. & Q. has a few through truss tables where a shallow floor is desirable. The C. M. & P. S. and C. M. & St. P. prefer deck tables, but use half through, through and pony truss tables. The Great Northern trusses through girders to overhead towers and thereby decreases the depth of pit to a minimum. The U. P. has pony trusses for its 100 ft. tables.

The Committee feels that the deck type of table is preferable to any other type on account of its low first cost, ease of operation and economy of maintenance but sees no serious objections to through tables where conditions demand their use.

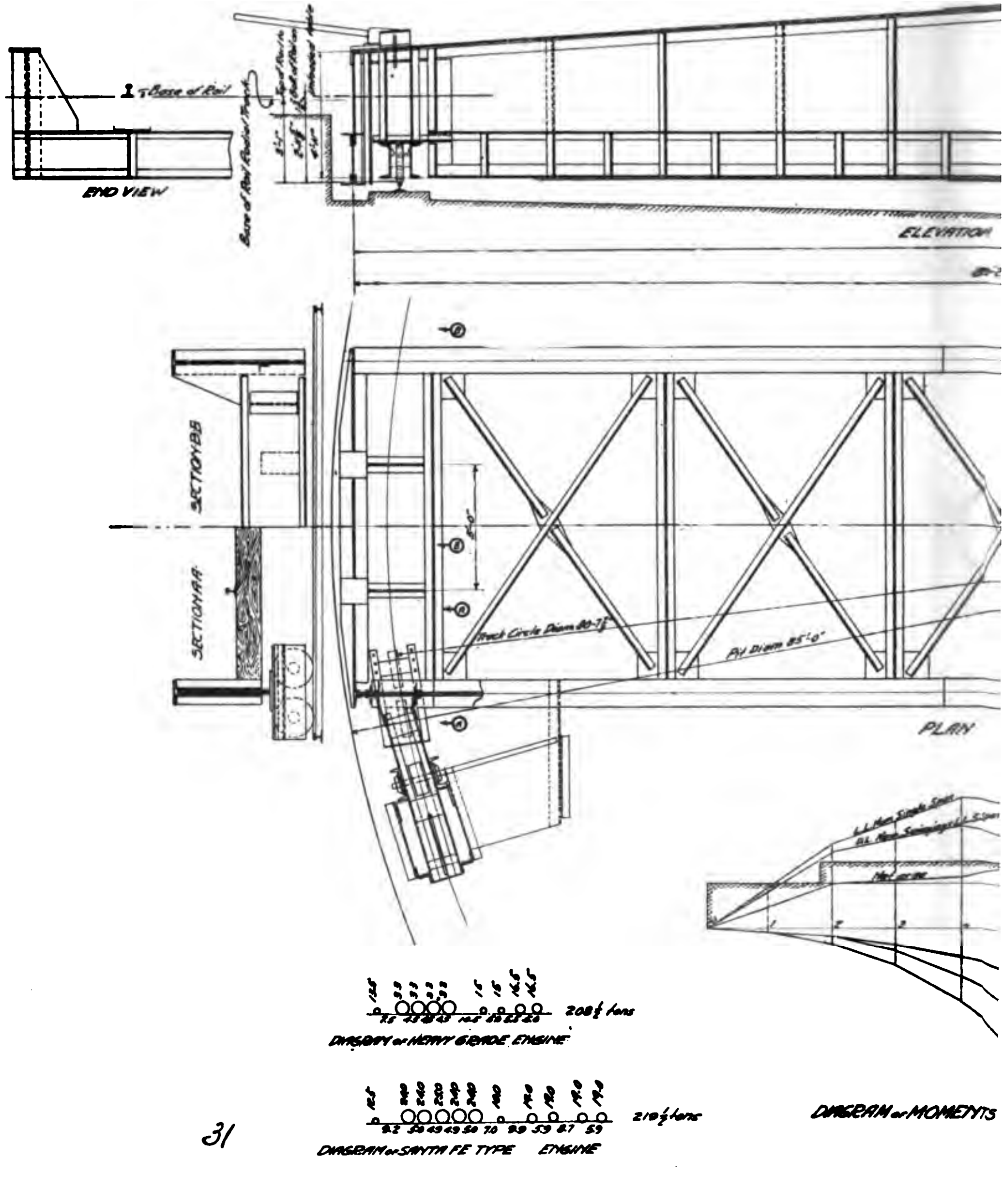
Where through girders are used the best practice seems to favor providing supports for the ties by means of steel stringers and floor beams instead of using deep ties resting on shelf angles. The deep ties are expensive in first cost and in maintenance, and promote corrosion of the girder webs and shelf angles. The steel cross girders at the center of the turntable require a depth at least as great as a standard floor system so the depth of pit need not be increased for the floor system.

The depth of pit for the shorter tables will probably never be sufficient to compel the use of short through tables, say less than 75 ft. The advantage of using through tables for the greatest lengths is indicated by the pit for the Pennsylvania 100 ft. deck turntable in which the depth from base of rail to top of catch basin is 11 ft. 2 in., while for the Norfolk and Western 100 ft. through turntable the depth is only 7 ft. 6 in.

Where through girders are used they should not be placed less than 15 ft. between centers as with a closer spacing the danger arises of men getting caught between an engine and the girder flanges.

Some slight use has been made of a shallow table that rests at the ends and center at all times and sometimes at other points, those tables being discussed more fully under "non-tipping tables."

Mr. F. G. Jonah expresses his opinion on this subject as follows: "I am inclined to think that the through turntables will be found to be the best for all long turntables, which will avoid the great depth of pit necessary for the deck tables."



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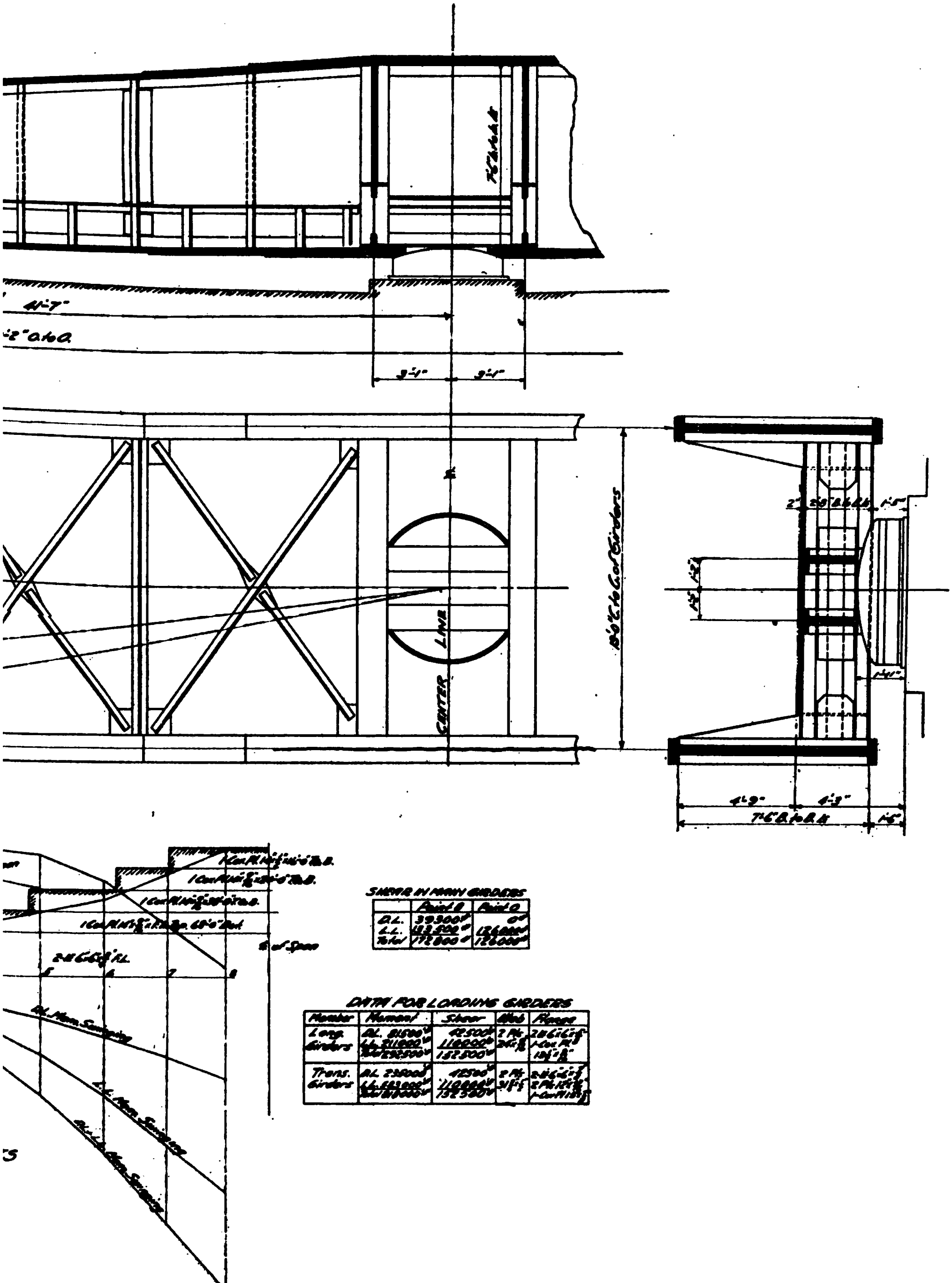
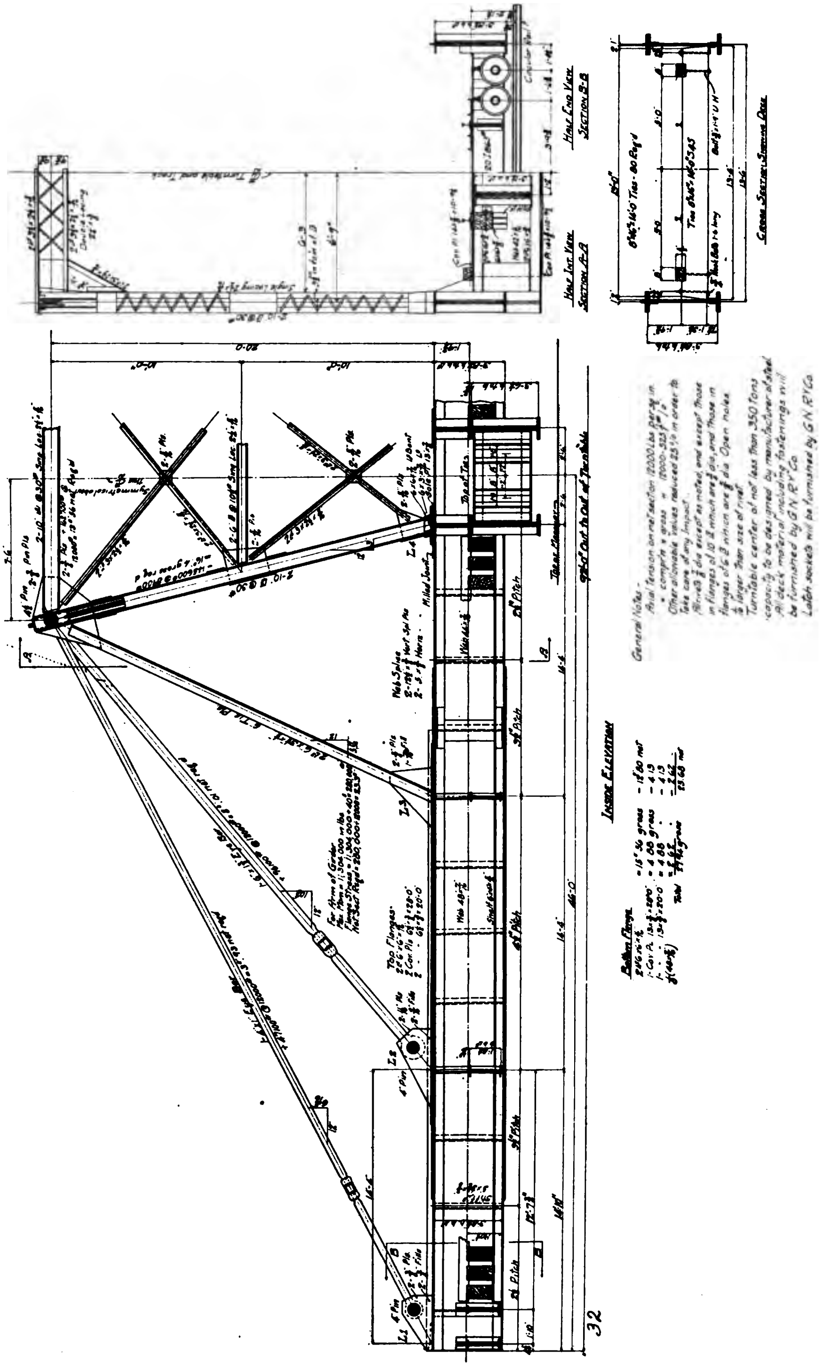
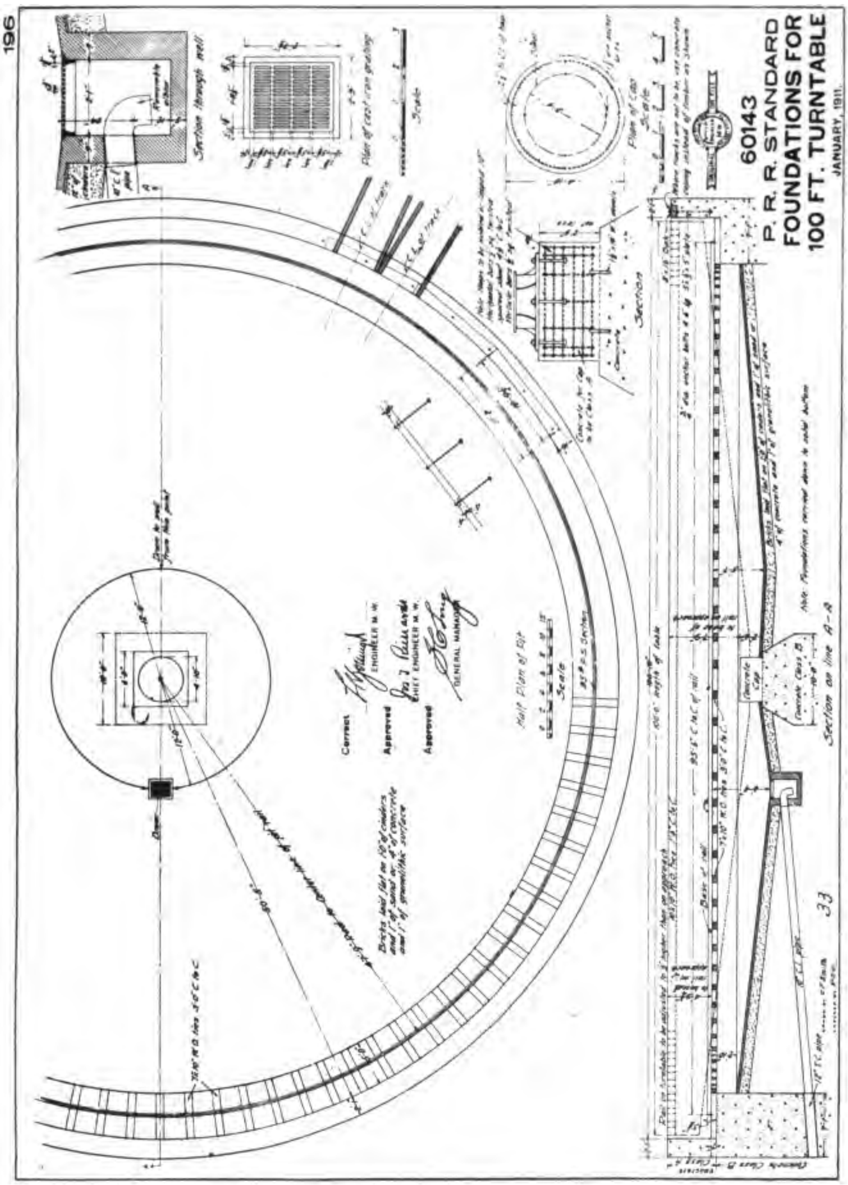
General Drawing of A. T. & S. F. Ry. System 85-ft. Standard Through Gir

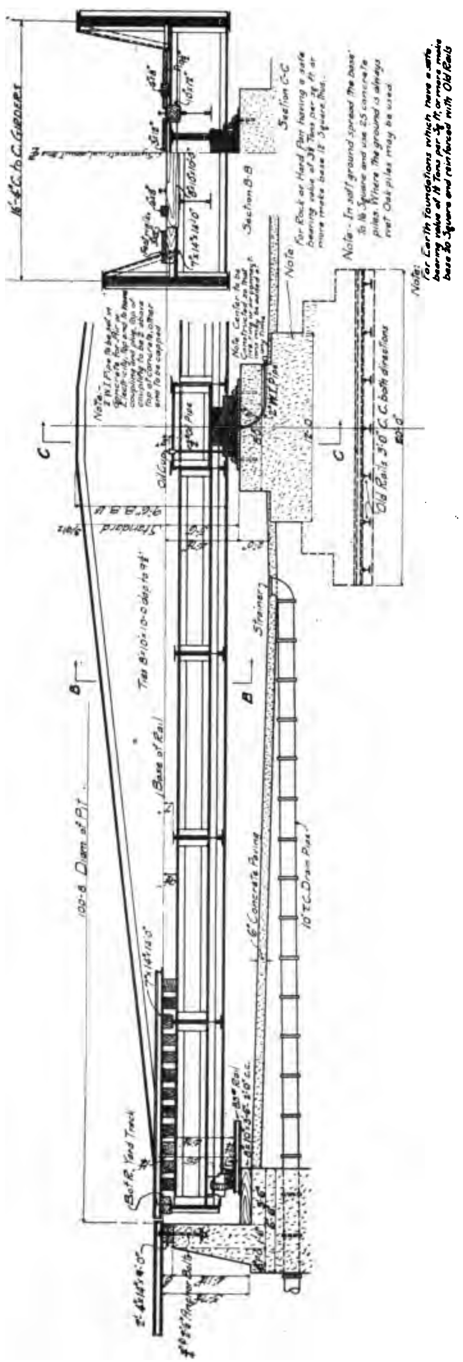


irder Turntable.

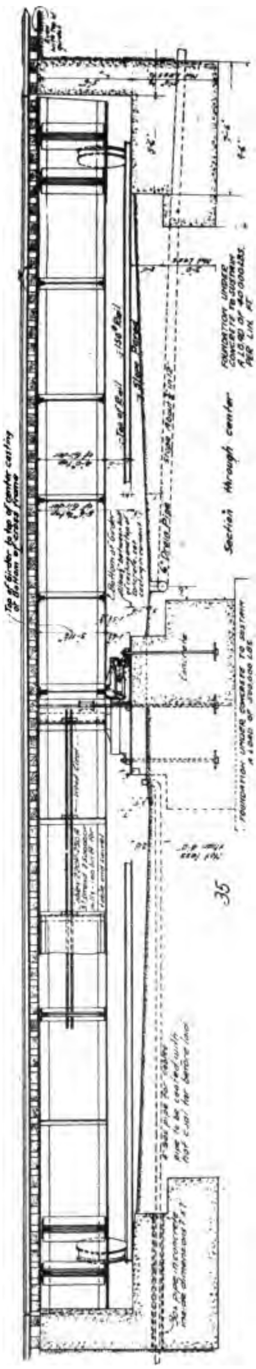


Standard 92-Ft. Through Girder Turntable with Through Overhead Trussing, Great Northern Ry.


196
60143
P. R. R. STANDARD
FOUNDATIONS FOR
100 FT. TURNTABLE
JANUARY, 1911.
Section through well
Plan of cast iron grating
Half Plan of Pit
Section on line A-A
Correct
Approved
Approved
ENGINEER M. W.
CHIEF ENGINEER M. W.
GENERAL MANAGER
33



Standard 100-Ft. Through Turntable, Norfolk & Western Ry.



General Drawing of Pit for Non-Tipping Turntable, Elgin, Joliet & Eastern Ry.

LOADING AND STRESSES.

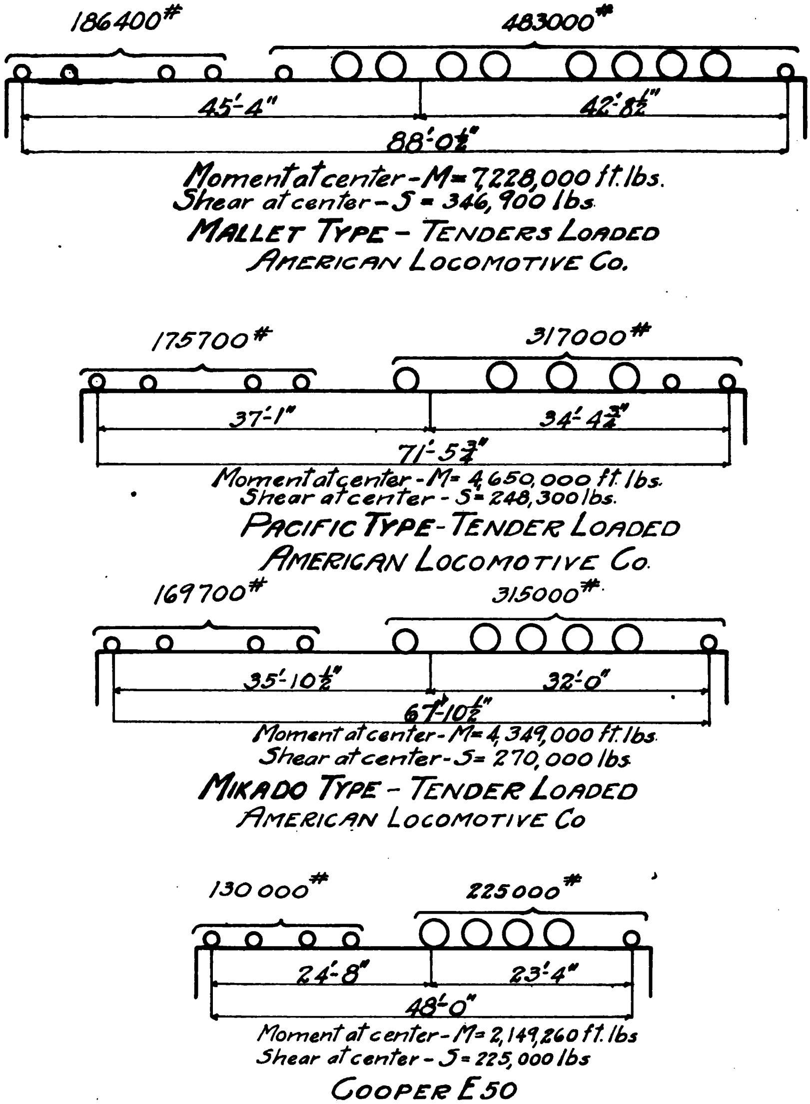


Diagram showing comparison between Cooper's E-50 and actual heavy locomotives as applied to turntable design.

The loadings and unit stresses used in the design of turntables are greatly diversified. Although Cooper's loadings are not adapted to turntable design on account of their short wheel base, 15 roads report their use in the design. The Boston & Maine, Long Island and Maine Central report the use of Cooper's E-50 (177½ tons); the Central Railroad of New Jersey, Chicago Great Western, Denver & Rio Grande, Mobile & Ohio, Philadelphia

and Reading, and Central of Georgia report the use of Cooper's E-55, (195¼ tons); the Bessemer & Lake Erie, Buffalo, Rochester & Pittsburg, Chicago & Alton and Lehigh Valley report the use of Cooper's E-60 (213 tons). On most of these roads impact is added to the stresses which are usually 16,000 lbs. per sq. in. tension and 10,000 lbs. per sq. in. shear, although in a few cases the impact is omitted and lower unit stresses are used, resulting in approximately the same weight of table.

Cooper's loadings modified by increasing the axle spacing and wheel base are used by several roads the engineers of which recognize the unsuitability of Cooper's loadings for turntable design. Among them are the seaboard Air Line which uses Cooper's E-50 with wheel base increased 50 per cent, and the Boston & Albany which uses Cooper's E-60 with wheel base increased 10 ft.

Other roads that report the weight of engine for which their tables are designed but give no other information along these lines are the Chicago & Eastern Illinois, Chicago, St. Paul, Minneapolis & Omaha, Colorado & Southern, Elgin, Joliet & Eastern, Illinois Central, International & Great Northern, Wabash and the Chicago, Rock Island & Pacific; all of which report the use of 200 ton tables; the Cleveland, Cincinnati, Chicago & St. Louis, and Pennsylvania which report the use of 225 ton tables; the C. M. & St. P. and C. M. and P. S. which report the use of 250 ton and some 325 ton tables.

Several roads have reported the use of special loadings as follows:

Name of Road	Weight of Engine in Tons	Stresses Used in lbs. per sq. in.		Remarks
		Tension	Shear	
A. T. & S. F.	243	8,000	4,000	
B. & O.	230 ton Mallet	10,000	6,000	
C. & O.	314 ton Mallet	10,000 Negative Moment... 12,000 Positive Moment...	6,000	No impact
C. B. & Q.	213½ ton Mikado	9,000	....	
D. & H.	Cooper's E-60	8,000	....	
D. L. & W.		10,000	6,000	
Great Northern 80'	180	10,000	....	No impact
Great Northern 92'	258½ ton Mallet	12,000	....	No impact
I. R. of Can.	200	8,000	....	
K. C. S.	240 ton Mallet	12,000	....	
L. S. & M. S.	210 ton Switcher	11,000	7,500	

Road	Weight	Tension	Shear	Remarks
L. & N.	192	15,000	......	Impact allowed
Mo. Pac.	200	10,000	7,500	
N. R. of M. 75'	200			
N. R. of M. 85'	254 ton Mallet			
N. Y. C. & H. R.	246 ton Mallet	10,000	7,500	
N. Y. N. H. & H.	190 ton Pacific	16,000	10,000	Impact allowed
N. & W.	9,000 lbs. per lin. ft. on one arm; 7,000 lbs. per lin. ft. on both arms	10,000	......	No impact
Nor. Pac.	219½	8,000	......	
P. & L. E.		12,000	......	Deflection of ends not over ½ in.
St. L. & S. F.	Cooper's E-55 and special Pacific and Mikado	10,000	10,000	50 per cent impact
Southern	263 ton Mallet	10,000	......	
U. P.	300 ton Mallet	10,000	......	

Turntables should be so designed that the deflection of the ends will not be so great as to cause both ends to drag while turning heavy engines, and it should not be necessary to place the rails on the table too high above the approach rails to accomplish this as that will result in too great a drop of the ends when an engine reaches the end of a table. In general the rails on the

table should not be more than ¾ in. above the approach rails and should come down level while engines are passing on or off. A deflection of ½ in. at each end then will leave ¼ in. clearance over the circle rail while turning. The unit stresses should be so chosen that the deflection of each end will be not greatly in excess of that amount.

Although a bridge designed for Cooper's E-50 or other Cooper's loading will support without any increase in stress over that used in the design actual modern engines considerably heavier than the Cooper's loading (on account of the longer wheelbase of the modern engines distributing the load over a greater length of bridge) the same engine on a turntable will cause the stresses that affect the deflection of the ends to very materially exceed those used in this design, for the reason that the longer wheelbase increases the negative bending moment on a turntable. This is well illustrated in the diagram comparing the effect and appearance of Cooper's E-50 loading to modern heavy Mikado, Pacific and Mallet type engines which cause stresses in bridges approximately equal to those caused by Cooper's E-50. On a turntable the negative bending moment at the center corresponds to that caused by Cooper's E-100 for the Mikado, E-110 for the Pacific and E-170 for the Mallet. If the turntable were designed for any such unreasonable values of Cooper's loadings the stresses in other parts would be increased out of all proportion to the requirements.

The reason why Cooper's loadings can not be used in turntable design is readily apparent from the above. It appears that the tables should be designed for the heaviest actual engine in service anywhere that could use them.

The unit stresses should be chosen low enough to keep the deflection down to a minimum, 10,000 lbs. per sq. in. for tension and the equivalent for compression, and 6,000 lbs. per sq. in. for shear being reasonable values. With those stresses it is not necessary to add any allowance for impact except at the ends where live load stresses in all parts subject to pounding should be increased 100 per cent to provide for impact.

Drainage.

The drainage of turntable pits, which has always been very important, becomes a much larger problem for the longer tables and deeper pits. Many engineers have had experience with pits that flooded during heavy rains or from flood water backing up through the drains.

Although tables can be operated under such conditions, the results are very bad, particularly on account of the damage to the center. In addition the water in the pit sometimes freezes and stops operation. After floods it is frequently necessary to take the center apart for cleaning and oiling with consequent delays to locomotives. While such delays might not seriously inconvenience operation at an outlying point where few engines are turned, they cannot be tolerated at busy terminals where it is of the greatest importance that the turntables be maintained in continuous service.

In former years when shorter tables were used the depth of the pit was not great and drainage could easily be secured without serious trouble or the accumulation of water would not be deep enough to cause trouble.

In case the lowest point of the engine house drainage is lower than the bottom of the turntable pit, the drainage of the pit can be made secondary to that of the engine house.

In any case the most efficient, economical and satisfactory drainage is provided by catch basins and gravity drains where the highest water in the outlet is lower than the bottom of the pit. Where this condition does not obtain the problem of drainage can be simplified in several ways, some of which are as follows:

Use of through type of table, thereby decreasing the depth of pit.

Use of shallow, non-tipping tables, that is, tables that rest on three or more points while turning.

Use of waterproof pits, with sumps and pumping.

Little has been done to handle the situation by waterproof pits, sumps

and pumping and it appears that the extra expense of waterproofing pits and providing and operating the pumps (even though they may be automatic), and the neglect that may be expected combined with the very deep pits necessary for modern deck turntables, is so great as to indicate the desirability of using through girders, provided direct gravity drainage can be secured for the through pits, but it also appears that a careful comparison of expense should be made before the through table is adopted.

Aside from occasional pumping of pits during floods or when drains stop up or for other special reasons, the only cases of regular pumping from sumps and ideas along that line that have been reported, are as follows:

The A. T. & S. F. contemplates water-proofing one pit and putting a trap in the outlet to prevent the river from backing into the pit. The C. C. C. & St. L. states that in case of difficult drainage the use of a water-proof pit with deck girders should be considered and compared with the cost of a through table. The E. J. & E. has one case where the sewer will be higher than the bottom of the pit. A manhole will be built a short distance from and lower than the pit. The water will be accumulated here and ejected by a cellar drainer, operated automatically by water pressure. The Mo. Pac. has one pit (among others) in which water backed up during floods. The drain was led into a sump and during rains the water that accumulates in the sump is raised by an ejector operated by steam from the shops. No special precautions were taken to waterproof the pit. The circle wall is of concrete and the pit is paved with brick laid flat with cement mortar joints. When the sump was constructed precautions were taken to make all surface water drain away from the pit. The Long Island reports: "Drainage not usually required," presumably on account of their pits being located in the sands of Long Island where the water seeps away.

Flooring Over Pits and Tables.

The old practice of flooring over the entire turntable pit appears to have almost entirely disappeared. Only two roads report flooring over the entire pit. The Great Northern reports that all pits are open except in extreme cases. At Cascade tunnel the entire turntable and pit are housed in. The Lehigh Valley states that pits are open generally. One pit is covered entirely to provide a driveway for a fire engine and one pit is covered entirely to keep the snow out.

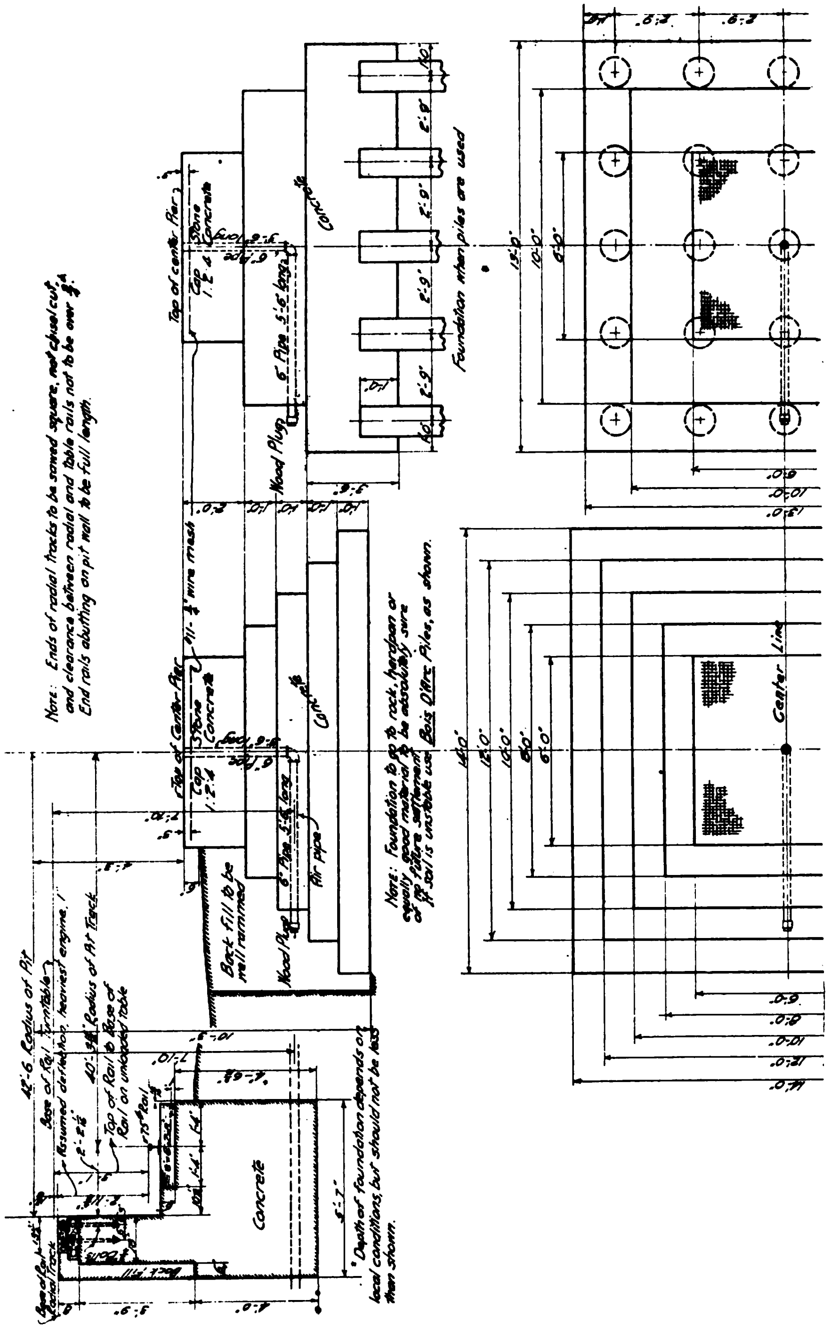
It is the invariable practice at the present time to use standard bridge ties on the stringers of through tables or on top of deck tables, with occasional ties long enough to support footwalks outside of the locomotives. The total width of the floor is 14 ft. to 16 ft. and sometimes foot railings are provided. In a few cases railroads have reported the use of pipe handrails on each side of turntables.

Center Foundation.

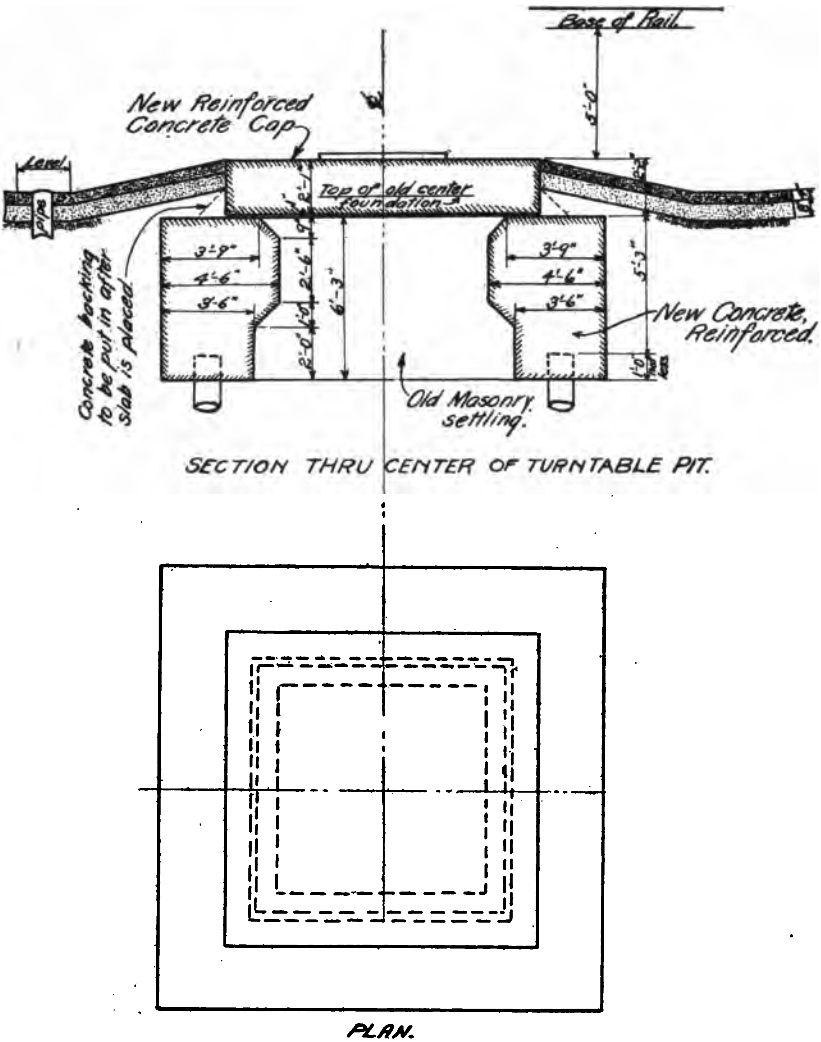
All railroads replying to the circular uniformly report the use of concrete foundations and the necessity of great care in construction of the center foundation. The great majority reported bases 12 ft. sq. on 16 piles; in many cases it is stated on the plans that footings must rest on bed rock or on piles. Footings as large as 16 ft. sq. with 49 piles were reported. Many roads reinforce the top or bottom of the center concrete or both. The cap, especially on old foundations, is frequently of stone. When installing new tables on old foundations requiring a change in elevation of the top of the center it is quite customary to cast a reinforced concrete capstone of proper thickness, which when properly hardened is substituted for the old capstone during the changing of the tables.

Many cases were reported of the settlement of centers having been stopped by excavating a trench around the footing, extending down two or three ft. deeper than the old footing, and underpinning the old foundation as well as extending the base by filling the trench with concrete, piles being driven where necessary.

The Chicago & Alton report the detailed method of carrying out such



Foundation Plan for Standard 85-ft. Through Turntable, A. T. & S. F. Ry.



Method Adopted for Strengthening Weak Foundations under Turntable, Chicago & Alton R. R.

a piece of reinforcement as follows: "We installed three new 90 ft. through turntables. In doing this we changed out three old 65 ft. deck tables and operating conditions were such that it was necessary for us to keep the old tables in service up to the last minute. The old centers were on natural foundations and in every case they had settled from two to eight in. so that it was not necessary to block up with a grillage placed between the top of the old foundation and the bottom of the center casting. We drove a row of piling around the old center and built a semi-reinforced concrete wall around the existing center. The top of the old center foundation was located about ten in. above the new concrete enclosing wall so there was no interference on

account of the new foundation wall. We cast a large reinforced concrete slab outside of the pit and when the old turntable was removed from the pit, the old capstone on the old center foundation was pried out and the new slab swung into place with a derrick car and leveled up on top of a mortar bed placed on top of the new enclosing foundation. The center casting for the new 90 ft. tables takes bearing on this large slab."

The practice of a number of roads that appear to take unusual precautions in this matter is as follows: The A. T. & S. F. plan calls for a footing 13 ft. square with 25 piles. A note on the plan says: Foundation to go to rock, hardpan or equally good material to be absolutely sure of no future settlement. If soil is unstable use piles." The B. & L. E. plan says: "Piles as shown (25) on swampy or filled ground: 15ft.x15ft. and rails (no piles) on natural bed, dry sand or moderately dry clay: 11ft.x15ft. (no rails) on dry gravel, hardpan, thick bed of dry clay: 8ft.x8ft. on shale and rock; increase width 1 ft. for every 2 ft. depth below 4 ft. from casting. When piles are used, excavate to ground water level. If there is no ground water use half the number shown of concrete piles."

B. & A. 15 ft. square and 25 piles.

C. & O. 12 ft. square and 25 piles.

C., B. & Q. Hexagonal shaped center 15 ft. wide with 19 piles.

C. M. & P. S. 10 ft. 6 in. square and 25 piles.

C. R. I. & P. 12 ft. 6 in. square and 25 piles.

D & H. 15 ft. square and 41 piles or less according to conditions.

Erie 14 ft. square and 25 piles.

I. C. 25 piles where not on rock.

K. C. S. Top reinforced with three layers of rails, top surface of top rails level with concrete. Six rails in top layer, eight in next, ten in next.

Long Island. Heavily reinforced top and bottom.

M. & O. 14 ft. square and 25 piles.

N. C. & St. L. 13 ft. square and 25 piles.

Nat. Rys. of Mex. 16 ft. square and 49 piles.

N. Y. C. & H. R. 13 ft. square and 25 miles piles.

N. & W. 16 ft. square and 25 piles.

If there is any possibility that air tractors may be used at any time in the future it is good practice to embed an air pipe in the concrete, bringing it to the surface of the concrete at the center of the cap.

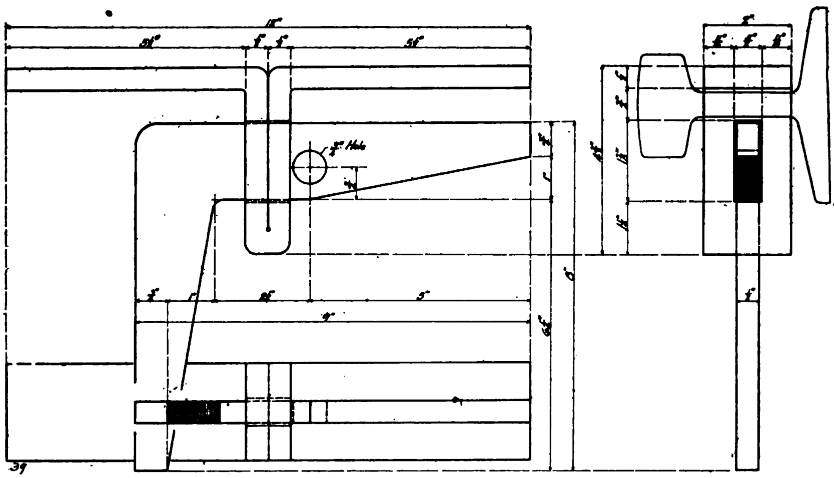
Locks.

Twenty roads report the use of the old fashioned wrought iron or wooden bar with wide ends forming an I shaped lock, sliding by hand between the webs of the rails, sometimes operated by a hand lever.

Five roads report the use of power brakes exclusively for holding turntables in position and several others report the use of power brakes on all tables operated by tractors.

Six roads report the use of a chair on the coping timber between the rails of each approach track into which drops the free end of a hinged bar, the fixed end of which is attached to the end ties on the table.

Five roads report the use of a chair on the coping timber between the



Lock for Turntable, N. C. & St. L. Ry.

rails of each approach track into which slides a tongue or toggle which moves between guides attached to the end ties of the table.

Five roads report the use of a socket in the circle wall for each approach track, into which slides a toggle bar or tongue attached to one of the turntable girders and operated by hand lever.

Five roads merely report the use of locks but do not describe the type.

The reports of a few roads are as follows:

C. R. R. of N. J. Sliding tongue on top of ties working in guides and operated by a lever which also operates a dwarf semaphore signal placed on top of the girders used at congested points where power is used. No lock where table is operated by hand.

C. M. & St. P. Usually a hand latch although in a number of cases it is operated by the man in charge of the motor.

K. C. S. Bar which is dropped over, engaging the rails.

Lehigh Valley. At important points locks and signals are provided. A sliding bolt engages a socket in the circle wall. Driven by a spring. Withdrawn by a cable.

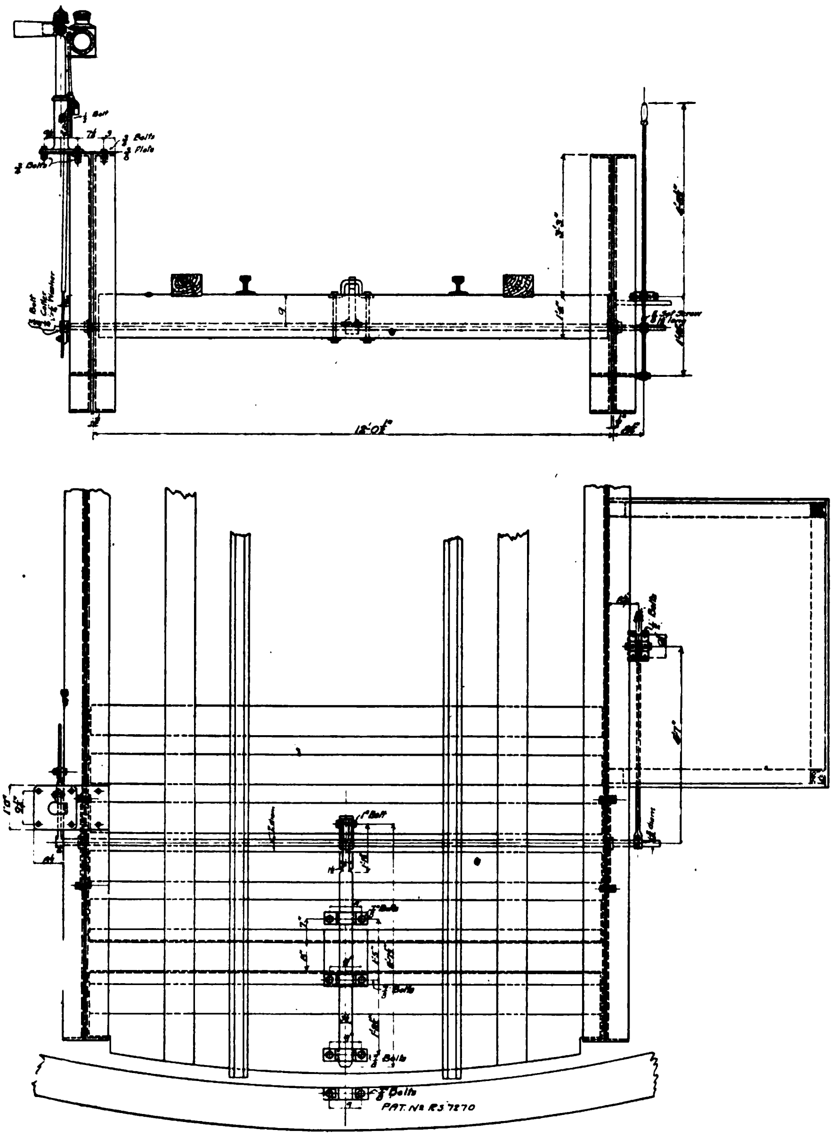
The Committee finds no necessity for locks where tractors are used, the power brakes being considered sufficient.

In all cases where tables are turned by hand locks should be provided. The simple I-shipped forging, sliding between the webs, answers the purpose as well as a more expensive and elaborate lock. Although it is convenient to have such a lock connected so that it will slide to and fro by the manipulation of a hand lever, it can be satisfactorily operated by hand, rings being attached to the forging for ease of handling if considered necessary.

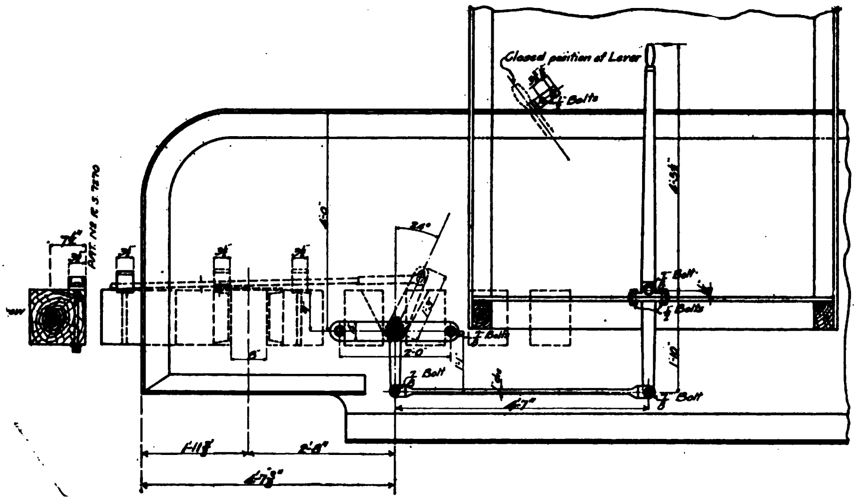
At outlying points it might be advisable to provide a locking attachment to hold the table in a fixed position to keep boys from playing with the table and getting injured.

Power for Turning.

Electric power where available has the preference on practically all roads. Turning by air motors appears to have the next preference for outlying points where tables are not much used and where current cannot be obtained and



Latch for Locking Turntables, Central R. R. of New Jersey.



Latch for Locking Turntables, Central R. R. of New Jersey.

where trouble with air motors, necessitating turning the table by hand, will not be serious. Gasoline engines are recommended for turning tables where electric current cannot be obtained and where liability of freezing renders the use of air motors objectionable.

A few roads report the use of steam tractors on their tables.

Expressions from a few roads are as follows:

A. T. & S. F.:—Air motors will work satisfactorily if proper care is exercised in the arrangement of the drainage to prevent freezing. The motor is not fool-proof, but it has given extremely good service on our lines.

B. & L. E.:—We would use no other power than electricity unless current could not be obtained.

B. & M.:—We have installed many gasoline motors, but are changing to electric motors wherever current can be obtained.

C. R. R. of N. J.: We use air supplied from locomotives.

C. & N. W.:—Electricity has proved very satisfactory and has been installed at all points where we generate our own power.

C. R. I. & P.:—We use air motors. We do not find these very satisfactory on account of the motors freezing up on our northern territory. In the future we will probably use electricity where current is easily obtained.

C. C. C. & St. L.:—We find air motors unsatisfactory on account of freezing in cold weather and more expensive to maintain than electric.

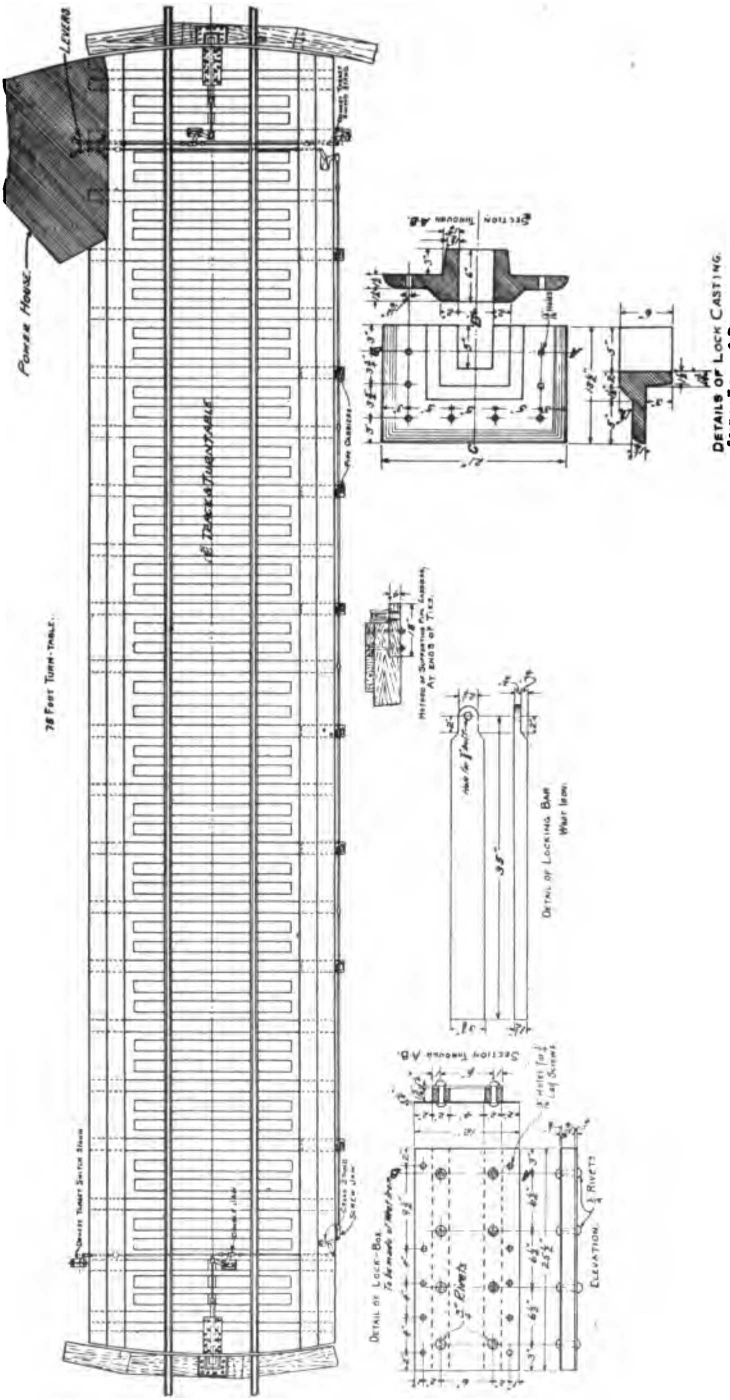
E. J. & E.:—We recommend overhead collector rings as we have had trouble from wires placed underground on account of dampness causing short circuits and ice in the pit affecting low collector rings.

Great Northern:—Gasoline is used only where air and electricity are not available. The objection to gasoline is the increased fire risk.

I. C.:—Air gives trouble in cold weather unless air pipes are placed underground.

Non-tipping Tables.

A short time ago there was considerable talk of having special non-tipping turntables, that is, the tables that would rest at all times at both ends and the center and in case of long tables, at intermediate points, which turntables would be quite similar in design to the present transfer tables. This practice has not developed to any remarkable extent, however, but some roads



Locking Device for Turntable, Lehigh Valley R. R.

are using a modification in providing heavy end carriages and motors on balancing turntables, so that for the shorter engines the turning can be performed in the regular way with the least work and for the longer engines balancing is not necessary as the motors are powerful enough to pull the loaded end truck around the circle.

The experiences of various roads along these lines are as follows:

Santa Fe: "Since we put the Mallet into service we have had to turn the table around when the load was not perfectly balanced. The motors we have been using are generally strong enough to handle the tables under these conditions.

The B. & O. and Nat. Rys. of Mex. report that their 80 ft. tables have end carriages for carrying unbalanced loads.

E. J. & E.: "We have three non-tipping tables located at Joliet, South Chicago and Gary. These tables are very hard to operate at times when the machinery is out of order. It is necessary to use a wrecking crane or a locomotive with tackle in order to get engines in and out of the roundhouse, while with the center bearing tables all that is necessary in case the machinery is out of order is to remove one of the gears and our largest locomotives can be easily turned by two men. The only advantage I know of in the use of end bearing tables is the reduction in the depth of the pit. This makes two spans of the table which greatly reduces the depth of the girders.

"Our 80 ft. center bearing tables are equipped with 15 H. P. electric motors, and it requires one minute and two seconds to turn a class 'A' engine on these tables. The 70 ft. end bearing table at Gary is equipped with a 30 H. P. electric motor and requires two minutes and eighteen seconds to turn a class 'A' engine. A 60 ft. end bearing table is equipped with a 10 H. P. electric motor, and requires two minutes and eighteen seconds to turn a class 'A' engine. The above is the average time required to make a complete revolution after the engine has been spotted from a dead stand still to a dead stop with the motor running at full speed. From this you will see that the speed of the center bearing tables is much greater than the end bearing table, and requires considerably less power to operate.

"We have experienced more or less trouble with the end bearing tables breaking in two in the center, and it has been necessary to reconstruct the center several times on this account. There is considerable expense in renewals of wheels on end bearing tables. These are short lived on account of the great weight they are required to carry."

N. & W.: "Where power is used balancing is not necessary. End wheels are made very heavy of cast or rolled steel, four wheels to each end with special cast wheel bearings arranged with oil boxes."

Southern Railway: "We have in service one table of the non-tipping type, that is, two arms or spans non-continuous at the center. This table gives a great deal of trouble on account of the wearing of the bearings of the end wheels. The pressure is very great at the end wheels and the wheels are equipped with roller journal bearings. These bearings wear very rapidly and allow the wheels to slew, with the result that the circular rail is pulled out of line, or the attachments of the wheels themselves are broken from the table. Our experience with this type of table has been decidedly unfavorable."

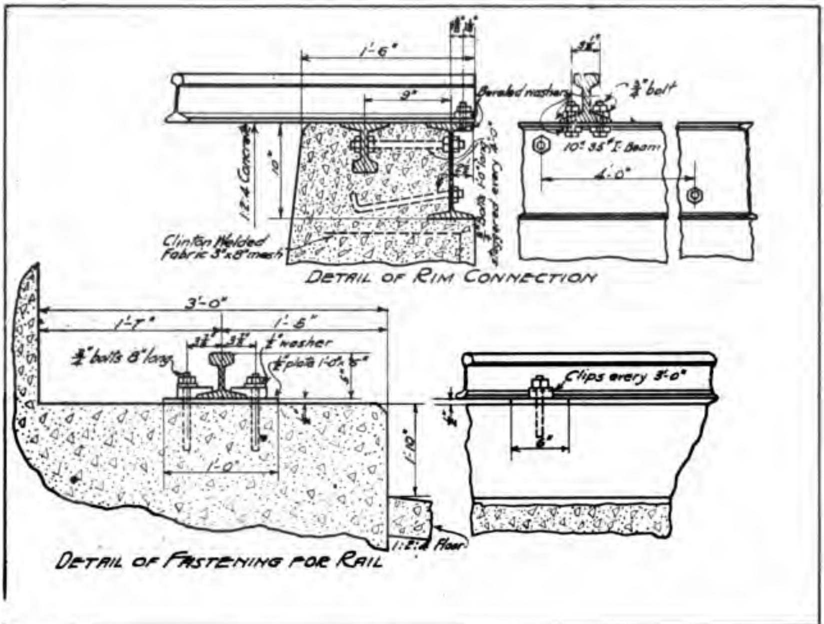
Circle Wall.

Thirty-five roads report the use of timber coping on the circle wall for the support of the rails of the approach tracks and of short ties set radially and resting on the concrete for the support of the circle rail, some using creosoted timber, tie plates and screw spikes.

Five roads report timber coping but rest the circle rail directly on the concrete, as follows: C. B. & Q., C. R. I. & P., C. St. P. M. & O., I. C., L. S. & M. S.

Nineteen other roads report as follows:

B. & A.:—The face of the circle is formed by a 10 in. curved I-beam anchored to the concrete. The ends of the approach rails are attached to the I-beam by bolts through the rail and flanges of the beam. The



Connections of Rails to Circle Wall, Boston & Albany R. R.

circle rail rests on 6in.x½in.x12in. steel plates every three ft., which are held down by anchor bolts set in concrete.

B. & M.:—In some cases the rails rest on steel plates on the concrete and are held down by anchor bolts and clips.

B. R. & P.:—The rails are secured by bolts and bevel washers to channel irons set in the concrete coping in later designs.

C. of Ga.:—The approach rails rest on coping timber. The circle rail is buried in concrete up to the bottom of its head. There are placed in the concrete under the circle three short pieces of old rail 2 ft. long under the position of the trailing wheels where the table is set for the main leads.

C. R. R. of N. J.:—The approach and circle rails are supported on castings. The concrete under the approach tracks is reinforced by two rails each 12 ft. long embedded upside down with their flanges level with the top of the concrete.

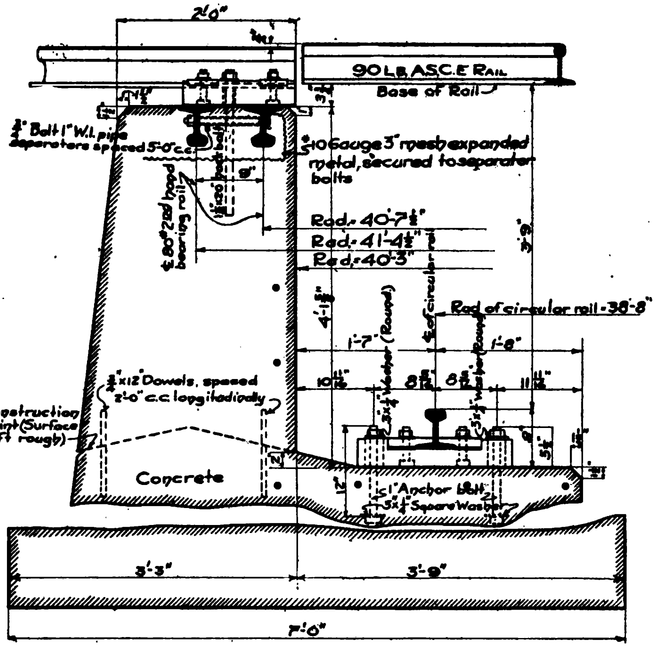
C. & E. I.:—In some cases the approach and circle rails rest on steel plates.

C. G. W.:—The approach and circle rails rest on concrete and are held down by rail anchors.

C. C. C. & St. L.:—The approach and circle rails rest on ¾ in. steel plates placed 20 in. centers and embedded in the concrete. At the main tracks the circle rail is carried on curved 12 in. I-beams 20 ft. long embedded in concrete and resting on short sections of rail 2 ft. 6 in. long every 3 ft. Similar arrangements should be used for the approach rails at the main points as the ¾ in. plates resting directly on the concrete are not adequate.

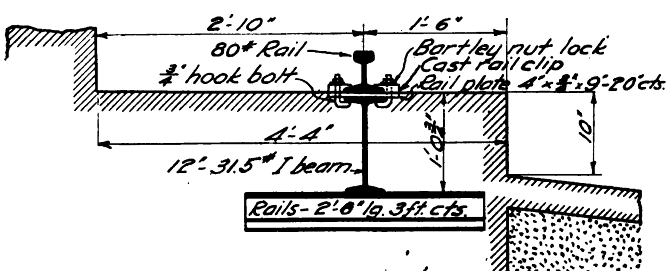
D. & H.:—The approach rails rest in riveted steel plate chairs anchored to the concrete. The circle rail rests on timber ties bedded in the concrete or directly on the concrete.

D. L. & W.:—The approach and circle rails rest directly on the concrete circle wall and are held by anchor bolts. The parapet wall under the approach rails are reinforced by the two curved rails embedded upright in the concrete.

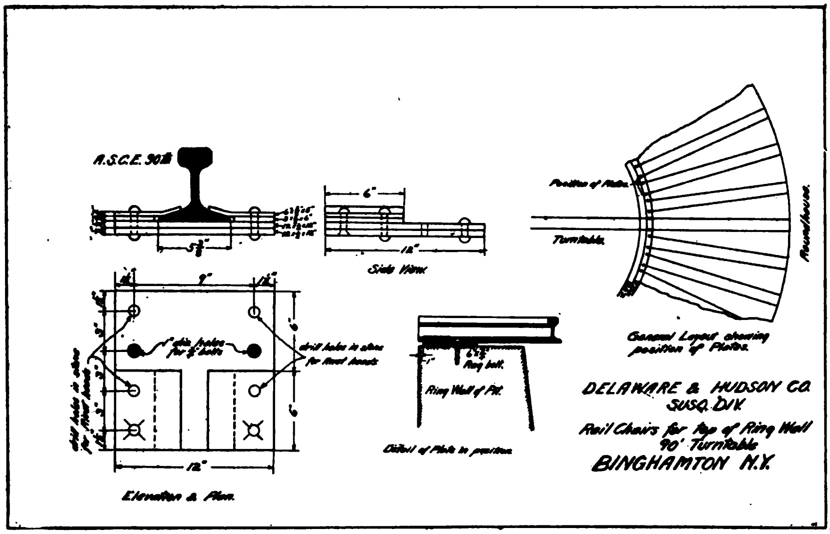


Section of Circular Wall of Concrete
Pit for 80 ft. Turntable
C.R.R. Co. of N.J.

Connections of Rails to Center Wall, Central R. R. of New Jersey.



Connections of Rails to Circle Wall, Cleveland, Cincinnati, Chicago & St. Louis Ry.



Connections of Rails to Circle Wall, Delaware & Hudson Co.

E. J. & E.:—The approach and circle rails rest on concrete anchored down by bolts set in drilled holes.

I. & G. N.:—The flanges of the approach rails are notched for spikes for 30 ft. from the circle wall to prevent creeping.

Maine Central:—The rails are held to the circle wall by cast iron clips and bolts.

N. C. & St. L.:—The approach and circle rails are attached directly to the concrete by steel clips and bolts.

Nat. Rys. of Mex.:—The rails are attached to the timber coping and ties or to cast iron chairs.

N. Y. C. & H. R.:—The rim of the circle wall is surmounted bv an 8 ft. 48 lb. Bethlehem beam bent to a circle and bolted down. The approach rail is bolted down. It formerly rested on two curved rails embedded in concrete. The circle rail rests on short ties in some cases, on concrete in others.

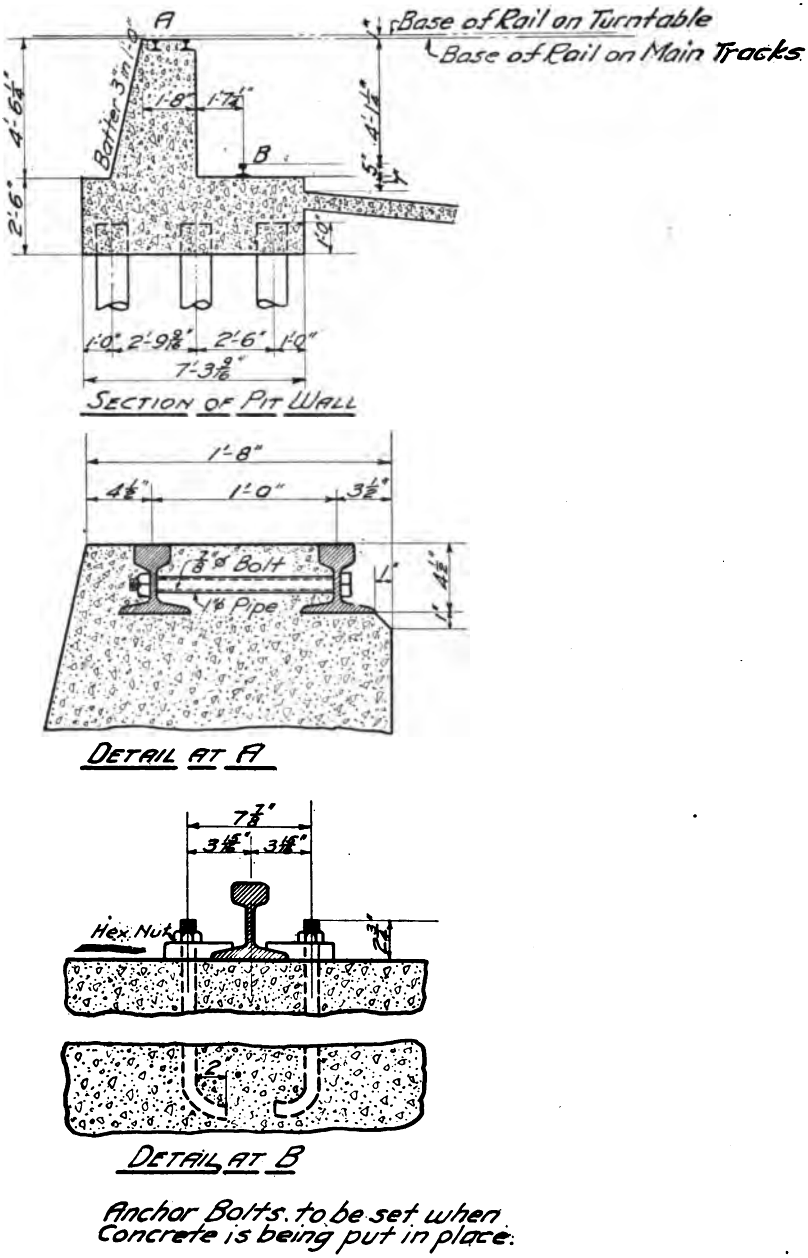
P. & R.:—The aporoach rails are spiked to coping timber. The circle rail rests on cast iron chairs, and is held down by clips and bolts on the concrete wall.

S. L. & S. F.:—The approach rails are spiked to the timber coping. The circle rail rests on and is partly embedded in concrete.

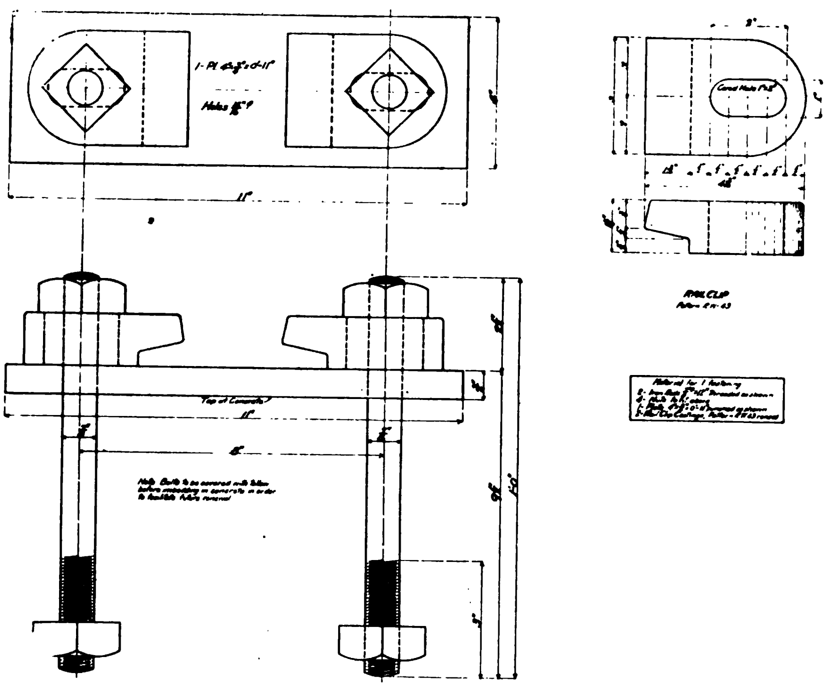
U. P.:—The approach rails are spiked to the timber coping. The circle rail is embedded in concrete with about ½ in. of head protruding.

Much trouble has been reported as the result of resting the rails directly on the concrete, especially under the main approach tracks and the above detailed description of the methods of reinforcing at such places shows the extent to which many engineers consider it necessary to go to avoid the trouble. Even where such rigid supports are provided there will probably be broken rails and other objectionable conditions resulting from the rigidity of the support, and it would appear that a timber cushion would be very desirable.

The Committee recommends providing a support for the ends of the approach rails on creosoted coping timbers, not less than 12 in. wide at the narrowest point, and preferably 8 in. thick, with two heavy standard tie plates under the end of each rail, where the rails are spaced so as to permit



Connections of Rails to Circle Wall, D. L. & W. Ry.



Connections of Rails to Circle Wall, N. C. & St. L. Ry.

this, or a special plate not less than one in. thick, 12 in. wide and long enough to pass under the two near rails of adjacent tracks, the plates to be drilled for track spikes or screw spikes and for lag screws for attaching them to the coping timber. The coping timber should be attached to the concrete by anchor bolts.

The Committee also recommends providing support for the circle rail by short creosoted ties about 15 in. center to center under main tracks and 24 in. elsewhere, with tie plates and screw spikes where available. To hold these ties in position and to prevent the accumulation of dirt, cinders, rubbish, etc., the space between them and between their outer ends and the parapet wall should be filled with concrete sloped to drain under the circle rail to the pit.

Although cut stone was universally used for circle walls in the past and many walls of such material are still in service, it is customary at present to build the circles of concrete except at such points as timber walls are used to effect economy or for temporary installations.

Where timber walls are used over hardpan or rock, blocking can be used but extreme care must be taken in placing the blocking to break joints and in drifting the timber together to keep the wall from crowding forward. Where the foundation is not firm enough for blocking, piles should be driven as long as possible to refusal, spaced about 3 ft. to 4 ft. center to center. Timber walls have been built and can be built in such a manner that they will be entirely satisfactory. On the other hand they have been built in such a manner that they have caused endless trouble. The greatest care should be taken in the construction of a timber wall.

Where a concrete circle wall is used the greatest care must be taken to secure a sound foundation for the wall and for the circle rail in order to

avoid settlement. To accomplish the desired result the footing should be extended to hard pan of rock or supported on piles driven to refusal. The piles should be placed directly under the parapet and circle rail. Great care must be taken in placing the bearings of the approach rails and in placing the circle rail to get a perfect level in each case. Some roads make the cross-section of the circle wall equal to that of a gravity abutment but this is not necessary if a complete circle be constructed as the arch effect permits the use of a considerably lighter wall.

It is of great convenience to have a recess in the parapet wall at some point and a concrete pit, constructed around the recess forming a so-called repair pit, through which ready access may be gained to the end of the table.

Paving of Pits.

Practically all railroads report the use of concrete or brick paving for turntable pits in standard installations at the most important points, concrete having the preference, but the majority of the roads also report many pits with no paving, the floor of the pit being finished with earth, cinders or gravel. There is no doubt that concrete or brick paving gives a much better appearing pit, but there is a question whether or not the expense is justified. The cost of paving, according to many of the plans submitted, will be close to $1,000. A porous layer of cinders or gravel 6 in. to 12 in. thick, will absorb all water and oil that runs into the pit and will prevent the occurrence of mud. The growth of vegetation should be very easy to stop. Mr. F. G. Jonah expresses his opinion on this subject as follows: "I think the bottom of all turntable pits should be paved. If they are not paved the rainfall in most sections of the country will wash away the cinders and stop up the drains, and will gully up an earth bottom if it is left that way."

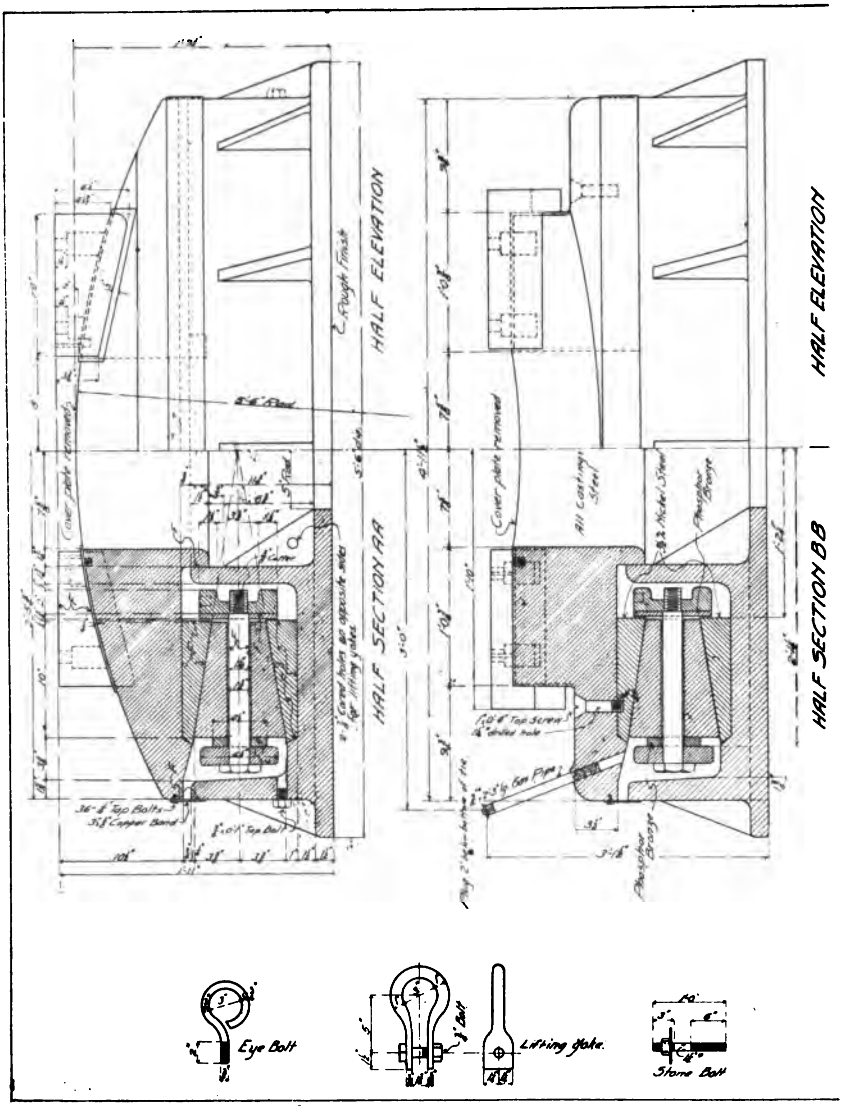
Cost.

Cost figures of turntable installations are of very little value, as the cost is affected by so many conditions, such as locality, condition of market for material and labor, congestion at busy terminals compared with isolation at unimportant points, the detailed procedure that must be followed, the time within which the work must be completed, drainage and other factors. The turntable is such an important adjunct that attention should be given to good design rather than to keeping the cost low. In a very general way, however, it may be stated that average costs of turntables, complete, installed with tractor, may be taken as follows:

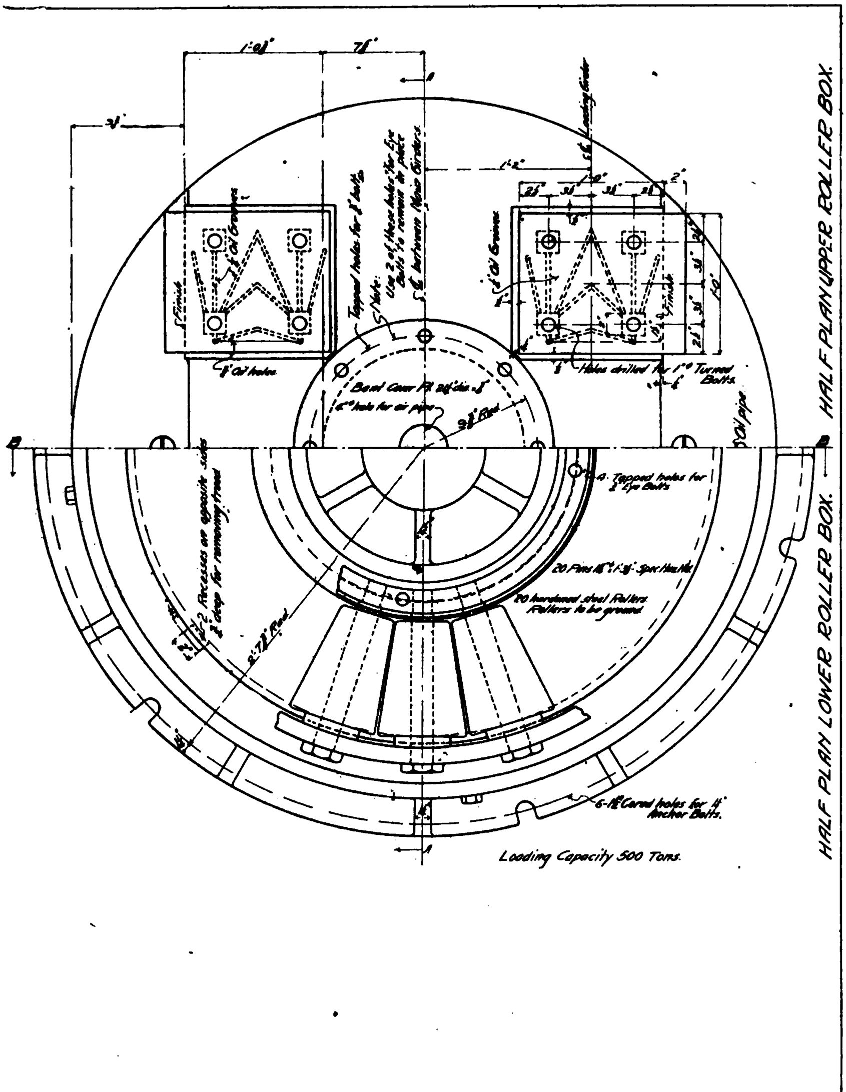
Deck tables, 75 ft.	$7,500
Deck tables, 80 ft.	8,000
Deck tables, 85 ft.	8,750
Deck tables, 90 ft.	9,500
Through tables, 85 ft.	11,500
Through tables, 100 ft.	15,000

The following figures were furnished by a number of roads:

A. T. & S. F.	85 ft. table, through	$11,000
	130 ft. table, designed for handling largest Mallet	20,000
B. & O.	80 ft. table,	7,500
B. & L. E.	80 ft. table,	8,500
B. & A.	85 ft. table, between 8,500 and	9,500
C. of Ga.	80 ft. table,	5,100
C. R. R. of N. J.	80 ft. table,	8,277
C. & O.	85 ft. table,	8,000
	100 ft table,	10,000
C. & N. W.	80 ft. table,	4,800
C. G. W.	90 ft. table,	10,760



Standard Turntable Center.



500 Tons Capacity, A. T. & S. F. Ry.

C. M. & P. S.	85 ft.	table, deck,	$ 10,630
		table, through,	12,430
		table, half through	10,900
C. R. I. & P.	75 ft.	table,	7,500
	90 ft.	table,	9,000
C. St. P. M. & O.	80 ft.	table,	4,720
C. C. C. & St. L.	85 ft.	table,	9,000
C. & S.	80 ft.	table,	5,800
D. & H.	90 ft.	table,	9,850
E. J. & E.	80 ft.	table,	6,500
Erie	80 ft.	table,	8,500
Grand Trunk	80 ft.	table,	6,000
Great Northern	80 ft.	table,	7,900
	92 ft.	table,	9,700
Illinois Central	85 ft.	table,	8,850
	75 ft.	table,	6,750
I. R. of C.	75 ft.	table,	7,700
I. & G. N.	75 ft.	table,	6,000
K. C. S.	90 ft.	table,	9,500
L. S. & M. S.	85 ft.	table, $6,500 to	8,000
L. V.	80 ft.	table,	8,700
Long Island	80 ft.	table,	4,980
Maine Central	80 ft.	table,	8,300
Mo. Pac.	75 ft.	table,	6,000
M. & O.	75 ft.	table,	5,750
N. C. & St. L.	90 ft.	table,	8,825
Nat. Rys. of Mex.	75 ft.	table,	8,100
	80 ft.	table,	9,000
N. Y. C. & H. R.	80 ft.	table,	11,000
N. Y. N. H. & H.	75 ft.	table, deck type,	7,800
		table, through type,	10,300
N. & W.	100 ft.	table, alone,	5,000
		Pits vary from 5,000 to	10,000
		Total, 10,000 to	15,000
O. S. L.	66 ft.	table, to 100 ft. in length have varied from 6,000 to	25,000
O. W. R. & N.	80 ft.	table,	8,000
Frisco	75 ft.	table,	6,500
S. A. L.	85 ft.	table,	9,000
Wabash	75 ft.	table,	7,550

Centers.

The center is the heart of a turntable. When that is out of business the turntable is out of service. The difference in cost between a very poor center and the very best center is so slight compared to the importance of avoiding trouble that the best centers available should be used.

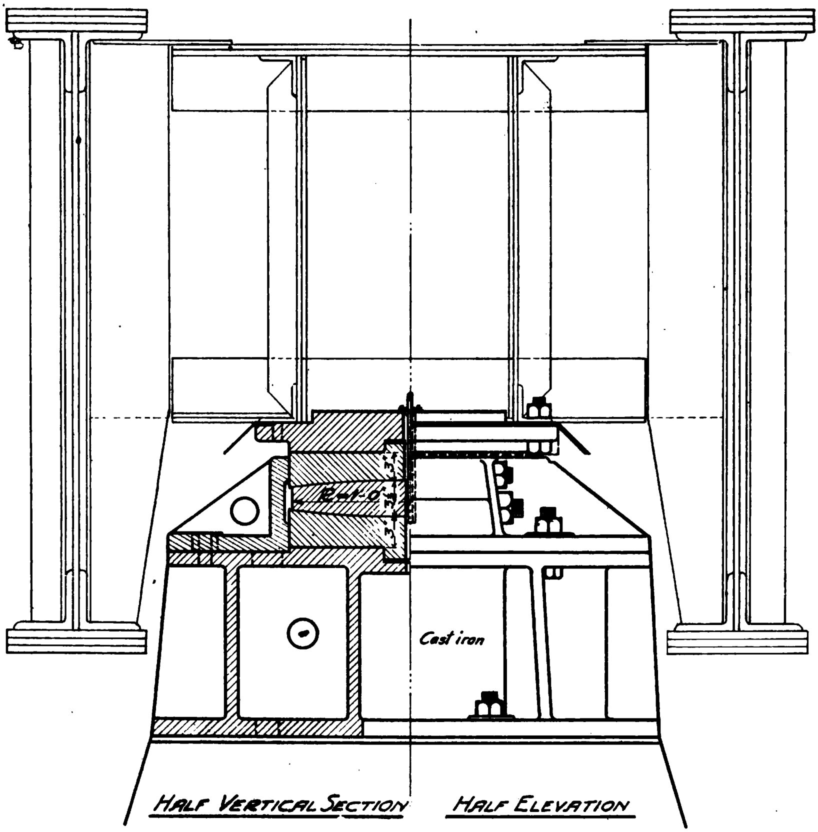
Forty-six roads reported the use of manufacturers' standards of conical roller bearing centers, some with ball bearings or phosphor bronse discs at the ends of the rollers to reduce friction, and others depending on the cast top and bottom sections holding theirs in position.

The roads using other than the above and the information furnished by them are given below:

A. T. & S. F.:—We have always used our own standard centers. While disc bearings work very well, the writer never succeeded in getting one that gave prospects of long life and easy turning.

B. & M.:—Disc centers.

C. R. R. of N. J.:—Our standard practice at the present time is to use a conical roller bearing center with a spider for keeping the rollers in their true position. It was found that rollers without the spider have a tendency to crowd out of position and line, causing the table to turn very hard under heavy loads. This is especially noticeable if the center of this type has



Disc Center for 80-ft. Deck Turntable, C. B. & Q. R. R.

been in service a year or so and the conical rollers have become somewhat worn.

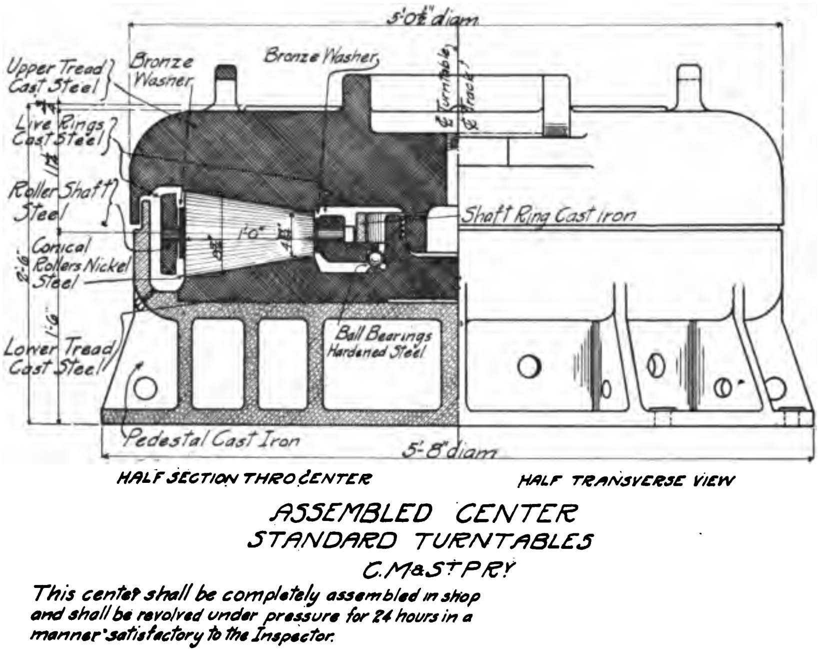
C. & N. W.:—Our experience with disc bearing centers has been that they operate very well with small turntables handling light power. Turntables handling very heavy power operate more satisfactorily with conical roller bearing centers.

C. B. & Q.:—We have used trade standards as a rule but are now designing our own. Conical roller bearings will not stand up under heavy power. We have had disc bearing centers in use three years and they are so far entirely satisfactory.

C. M. & P. S.:—We use a special standard conical roller bearing center with ball bearings. We have tried only one disc bearing center which was not at all satisfactory and had to be removed.

C. M. & St. P.:—We use our own design of center which has conical rollers with ball bearing ends. It cost about $1,000. We have had some experience with disc centers which were not satisfactory.

C. C. C. & St. L.:—Disc centers are standard. We have used trade standards in tables less than 85 ft. long. Our experience with disc centers has not been extensive but we are convinced that the advantages in maintenance will more than offset the slightly greater power required to turn. The



Cross-section of Standard Turntable, 325 Tons Capacity, C. M. & St. P. Ry.

conical roller bearing as ordinarily designed is entirely too small for the loads carried and the cost of maintenance is excessive.

Erie:—We use conical roller bearing centers with ball bearings at the ends of the rollers. With heavy power we have experienced trouble with the balls and have substituted discs for the balls at the ends of the rollers.

I. Ry. of Can.:—We use ball bearing centers. We have had some good conical roller bearings and some that failed by flattening.

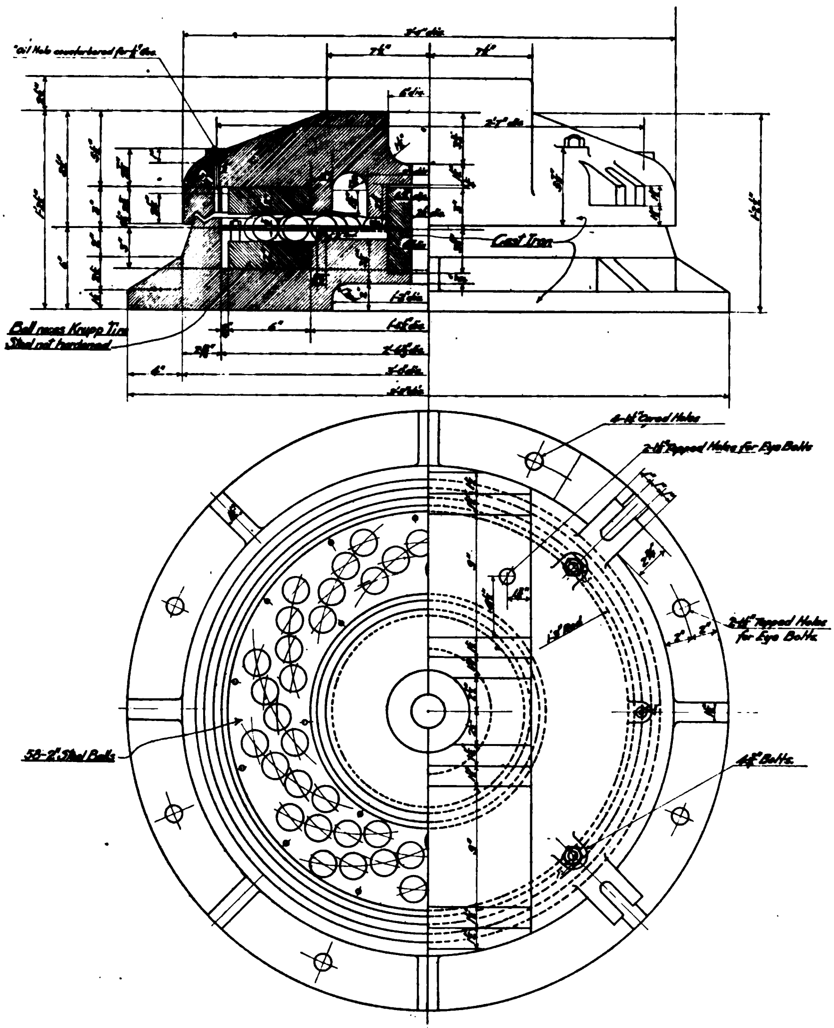
Lehigh Valley.:—We use conical rollers with a live ring. All conical rollers are provided with independent bearings. Disc bearings for modern turntables and loadings are not satisfactory on account of the heavy pressure preventing proper lubrication.

M. C.:—We use disc centers according to N. Y. C. standard.

N. Y. C. & H. R.:—We use disc centers.

It will be noticed that both disc centers and conical roller centers have their adherents, the Boston and Maine, Maine Central, Chicago, Burlington and Quincy, Cleveland, Cincinnati, Chicago and St. Louis and New York Central & Hudson River reporting the use of disc centers. The Intercolonial Railway of Canada reports the use of ball bearing centers in which hardened steel balls two inches in diameter roll between the top and bottom castings. The latter has been used under short tables of light capacity; it would probably be impossible to get a satisfactory center of such design for modern heavy loads.

The conical roller centers appear to be satisfactory if properly designed, costructed and maintained. Improper attention to these features has caused much trouble and much criticism of this type of center. One of the principal faults with the design of former conical roller centers was the small length of the rollers which created unit pressures greater than they should have been. This resulted in the wearing and flattening of the rollers and in the



BALL BEARING CENTER FOR 60 FT. TURNTABLE

wearing of the rollers into the surfaces of the top and bottom castings. The conditions could be improved by planing the castings but the trouble usually resulted in the renewal of the rollers and of the castings, practically the entire center, which was expensive. In later designs the length of the rollers was increased and track plates were attached to the top and bottom castings so that in case of wear the track plates and not the entire castings are renewed. The rollers and track plates should be of hardened steel and the castings of steel.

In the earlier designs of conical roller centers no means was provided for keeping the rollers a constant distance from the center although there is a tendency for them to crowd out or to work in on radial lines. Their working in, which seldom took place, resulted in their rubbing on one another with consequent increase in difficulty of turning. Their crowding out resulted in the top and bottom castings coming together and rubbing and in the outer ends of the rollers working against the rough inner surface of the castings with the consequent damage to rollers and castings and increase in difficulty of turning.

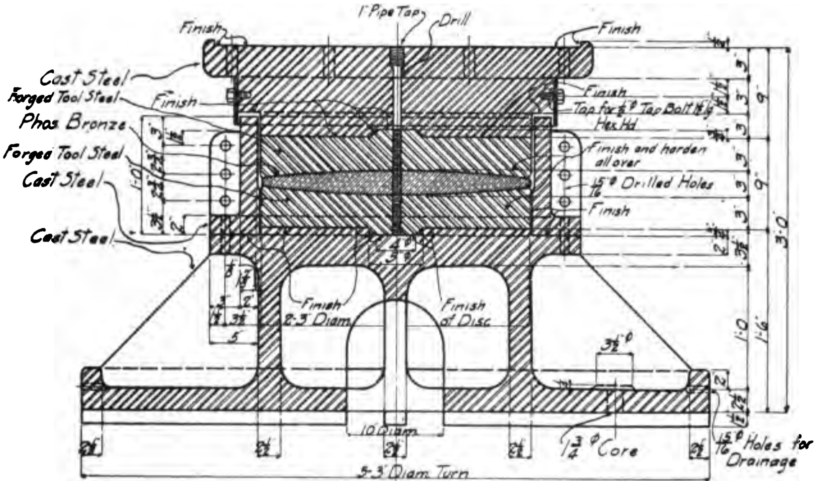
In later designs, and more particularly for the heavier tables, means are provided for holding the rollers in line. Some makers do this by placing the rollers in a depression of the bottom casting, the casting being raised at the outer ends of the rollers to make contact with their ends and rubbing takes place here during turning. If the rollers are of steel and the casting also of steel as should be the case, cutting may result if there is any tendency for the rollers to crowd out. The most approved practice consists in the placing of a steel ring, called a live ring, around the rollers, set screws or lugs projecting from the end of each roller or bolts passing entirely through the length of the rollers and through the live ring; this ring answers the double purpose of keeping the rollers from crowding out and keeps them the proper distance apart. In some designs, especially where bolts pass through the rollers, rings are provided in a similar manner for the inner ends of the rollers, which with the bolts, form a spider.

If the rollers work in or out against the live rings the rubbing causes friction that cuts into the metal and increases the difficulty of turning. To overcome this, phosphor bronze frictionless washers, or ball bearings are provided in many designs between the ends of the rollers and the live ring.

Conical roller centers without separate track plates or live rings are doing excellent service at many points, and trouble has been encountered in many cases with centers having the above mentioned improvements. As a general rule, however, for heavy tables that will be subjected to frequent service, every possible effort should be made in the design, construction and maintenance to reduce friction to a minimum, by the use of the above improvements.

The best practice in drawbridge design favors the use of disc centers under the largest draw spans and that type of center is carrying successfully, spans weighing in excess of 1,000 tons. In view of this it seems very odd that an overwhelming majority of the roads favor conical roller centers for turntables and many engineers replying to the Committee's circular stated that disc centers will not stand up under heavy turntable loads.

On the other hand several roads have had very successful results with disc centers as mentioned above. In reply to special letter of inquiry the Chicago, Burlington and Quincy Railroad reported: "We have had a through turntable in operation at Kansas City with one of these centers for several years and it has proven entirely satisfactory. This is a very busy point and the heaviest engines we have except the Mallets are turned on this table. We have just installed at Galesburg the first disc center under a deck table. This is also a busy point where the table is handled by a tractor. They advise that with the new center they use only one-half of the men we used with the old conical rollers. This center at Galesburg was made by the Vulcan Iron Works and cost us $427 for the center and $69 for the pattern. I am surprised to know that other companies have had better success with the conical roller centers. I do not know of a single center of this type on our



DISC CENTER
MISSOURI PACIFIC RAILWAY
1000 TON DRAWBRIDGE
(Shown here for comparison with Turntable centers)

lines under constant heavy service that does not make trouble while the disc centers so far installed have been entirely satisfactory."

A Committee of the New York Central Lines which investigated the matter of centers recommended the use of disc centers and they are standard on those lines.

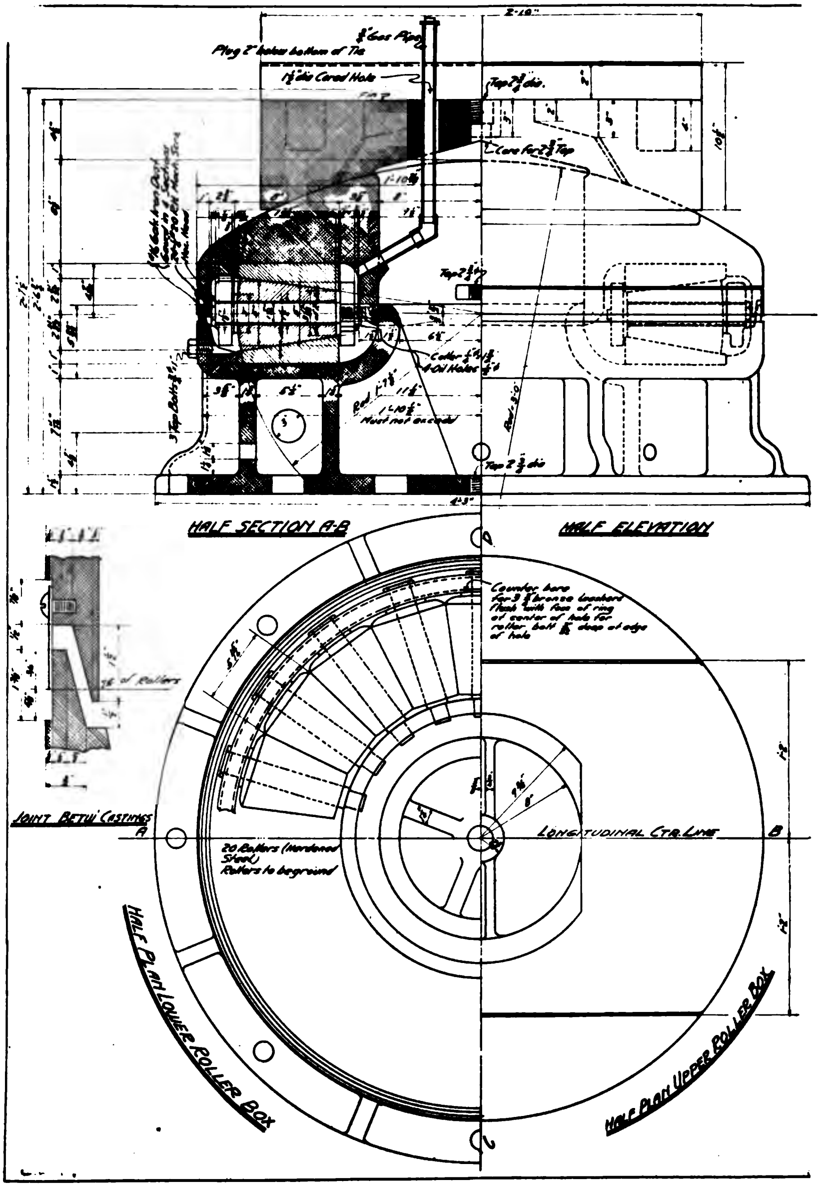
The oiling of the moving parts of the center whether rollers, balls or discs is very important. The bottom casting should be so designed that the rollers, discs or balls can move in a bath of oil, and the top casting so designed that cinders, dirt or other grit can not get inside. A mixture of black oil and signal oil is excellent for the lubrication of centers. They should be flushed out frequently by kerosene or gasoline, and should be taken apart and cleaned whenever they begin to turn hard.

The illustrations accompanying this report show the distinguishing features of a number of the best turntable centers.

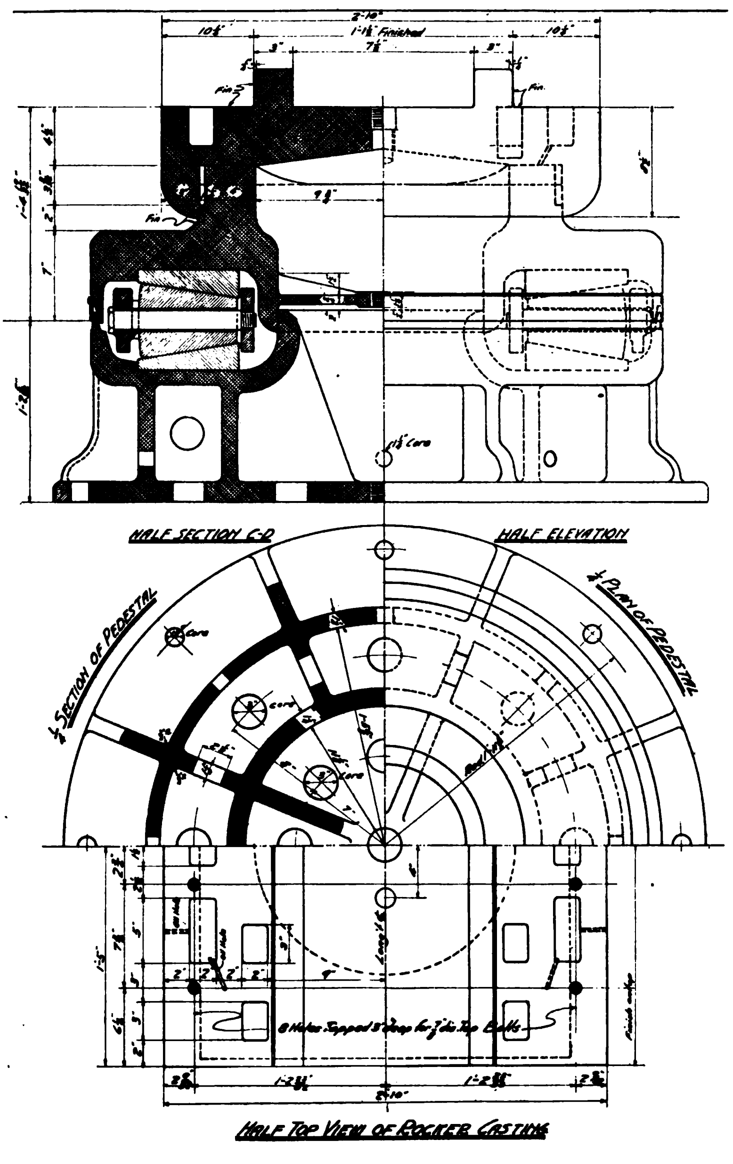
While the Committee does not feel itself justified in recommending disc centers, in the face of the extended use of the roller bearing centers, which in many cases are satisfactory, it does recommend that properly designed disc centers be given serious consideration.

Frogs in Approach Tracks.

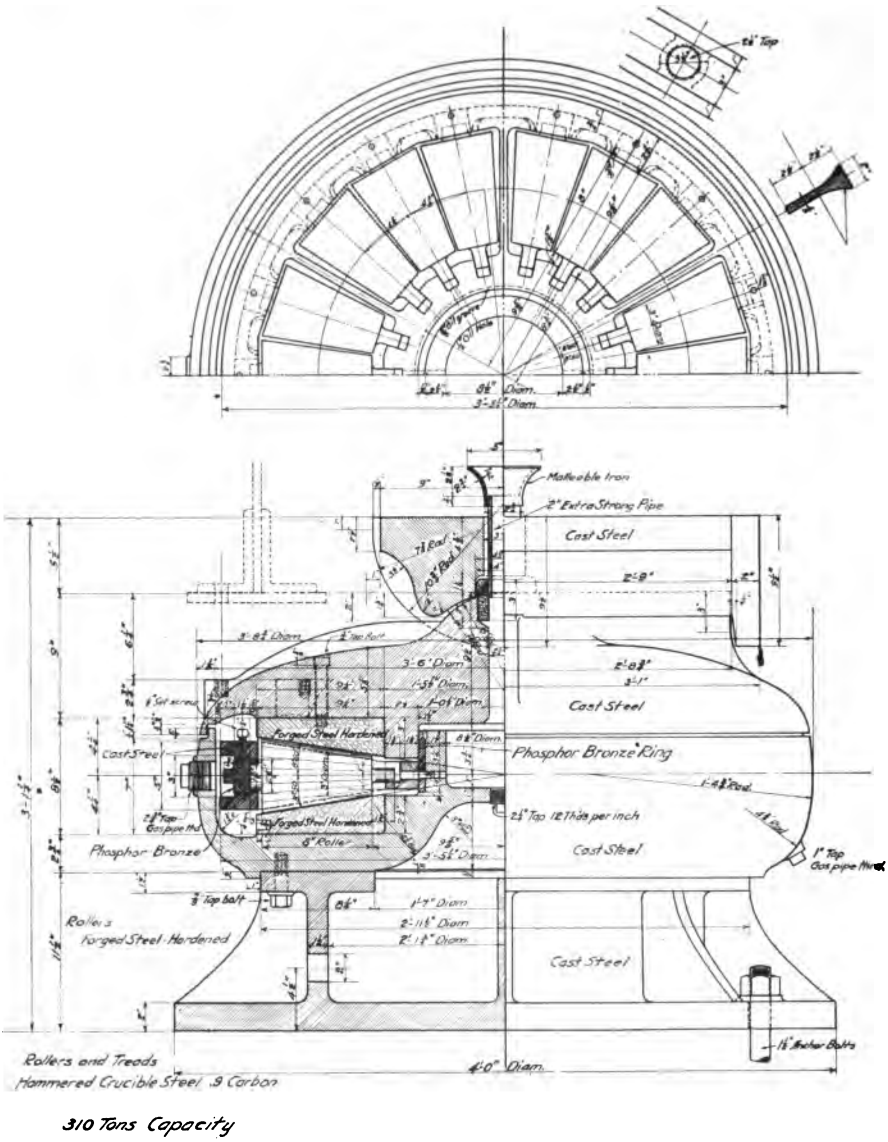
About 50 roads report that frogs are not used in their standard lay-outs, but are used in special cases where new tables are installed in old lay-outs. About ten roads report using frogs in their standard lay-outs, usually for the purpose of getting more stalls in a complete circle. The Committee recommends that the use of frogs in approach tracks be avoided where possible to avoid them and that standard lay-outs be prepared with that object in view.



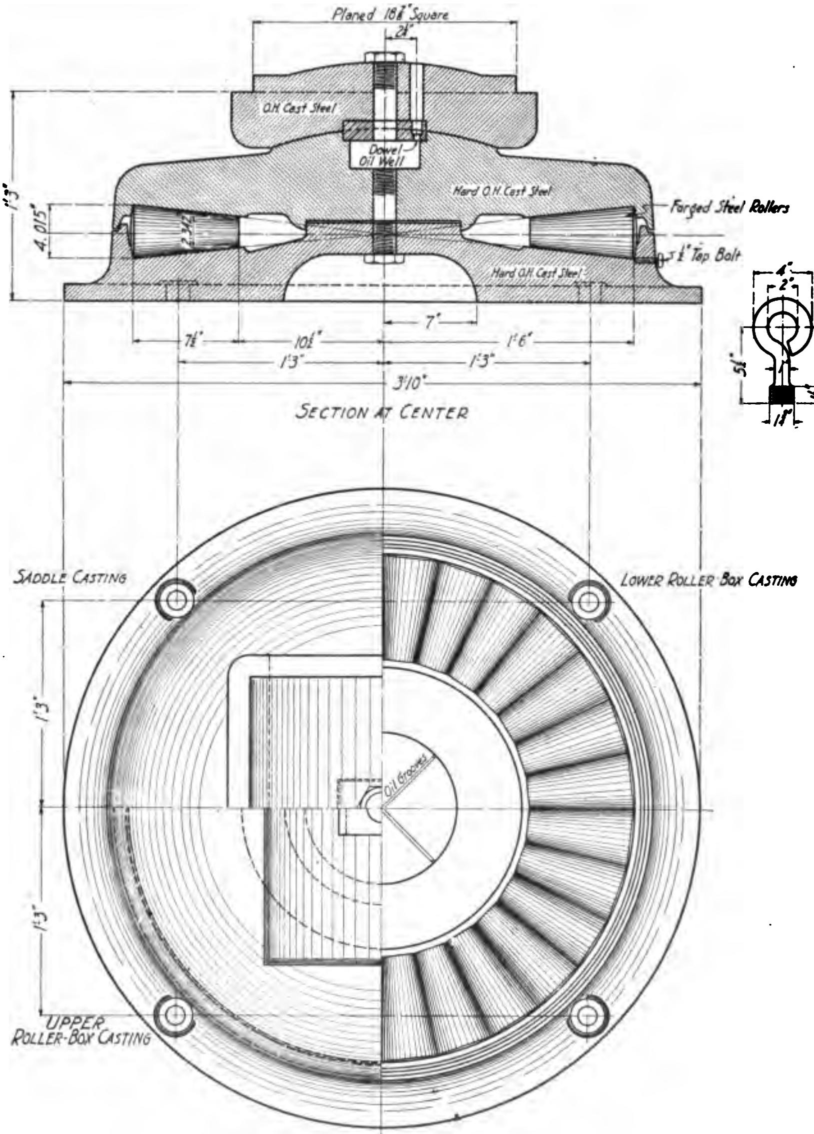
Standard Turntable Center.



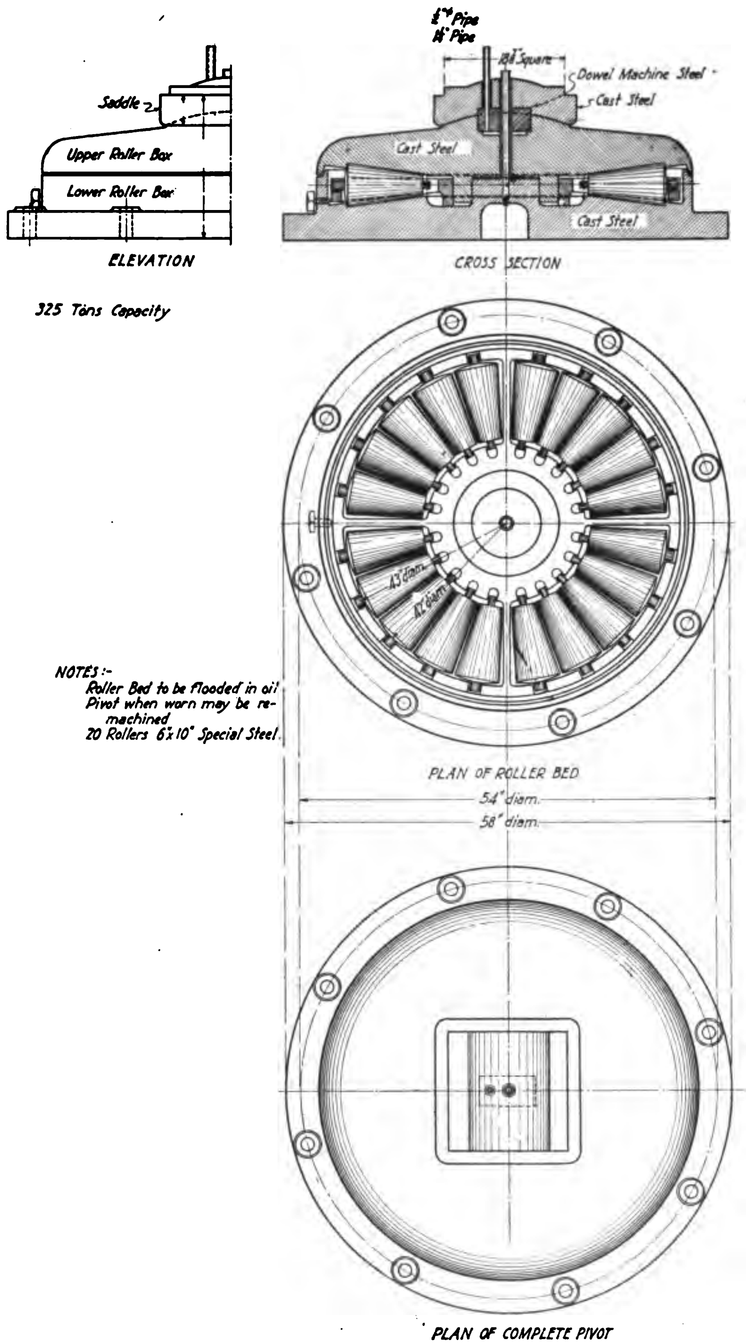
American Bridge Company.



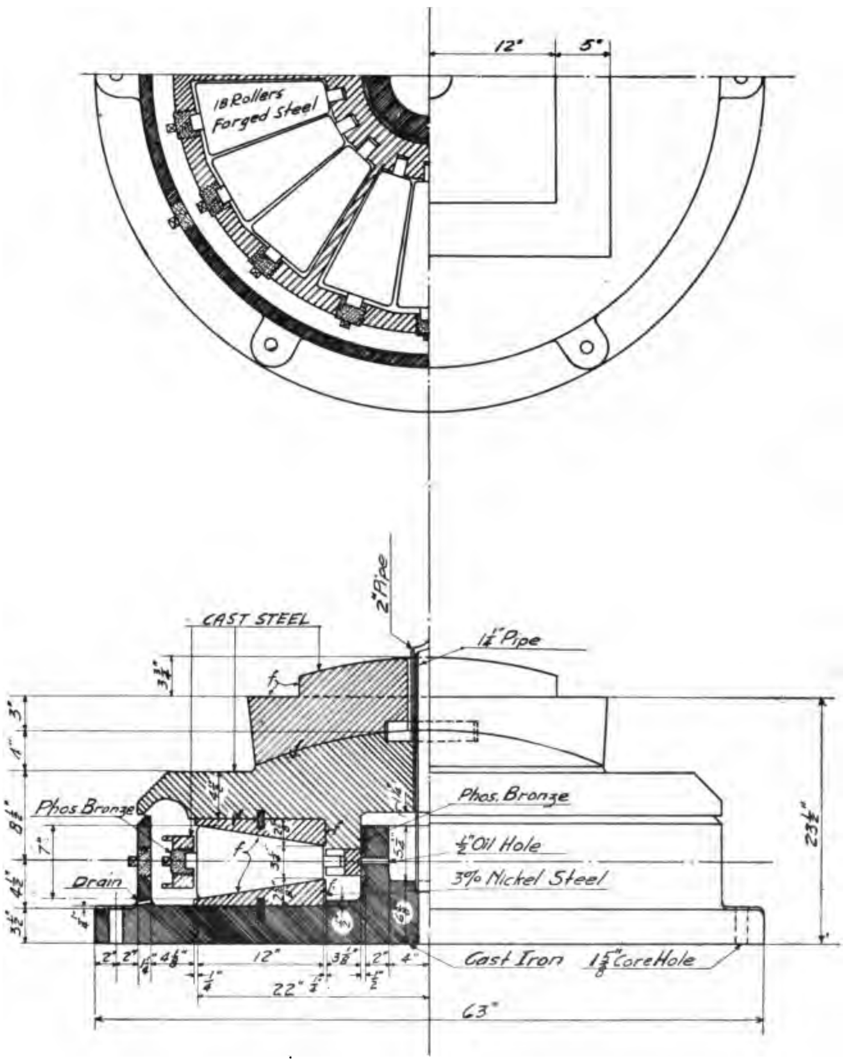
Standard Turntable Center, 310 Tons Capacity, Pennsylvania R. R.



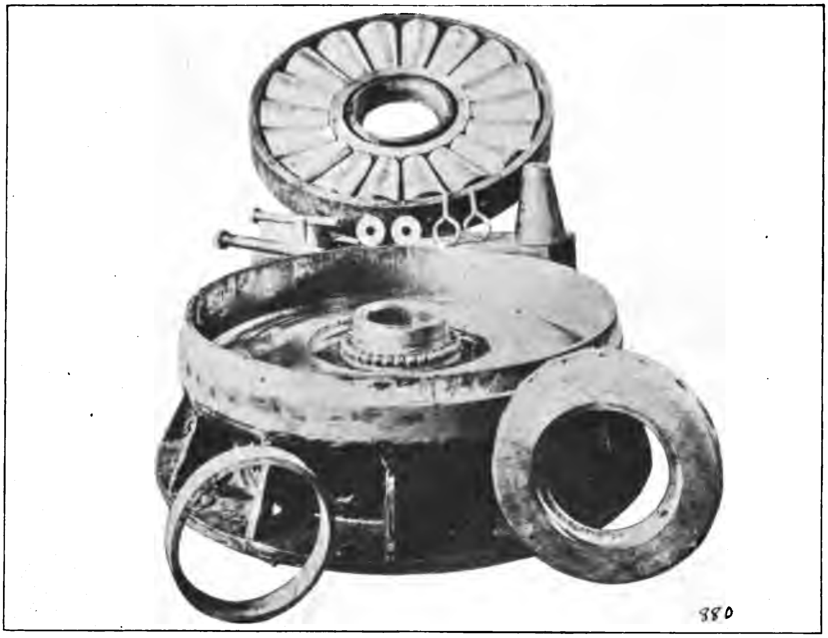
Standard 200-Ton Turntable Center, Philadelphia Turntable Co.



Standard 325-Ton Turntable Center, Philadelphia Turntable Co.



Standard 375-Ton Turntable Center, Philadelphia Turntable Co.



Standard Roller Centers for 85 ft. and 90 ft. 300-Ton Turntable, 105 ft. 325-Ton Turntable, Chicago, Milwaukee & St. Paul Ry.

Other Means of Turning.

All the roads report the use of wyes where convenient for turning engines, but tables are invariably used for getting to roundhouses. There are a few exceptions; for example, the Great Northern reports: "At Judith shops, Montana, we have an eleven stall rectangular engine house, seven stalls on one side and four on the other and a track arrangement providing a turnout to each stall with a wye for turning."

The Santa Fe reports: "On our Eastern Railway of New Mexico where we have three 90 ft. tables in service we are using what is known as the double Prairie Mallet engine. A pair of short outriggers are fastened to the rails at one end of the table and this allows the rear wheels of the tender to run beyond the end of the rail, perhaps ten or 15 inches. For the other Mallet engines, that is, the double consolidation or freight Mallet and the double Santa Fe Mallet, we have not provided any tables, but are turning the engines on wyes. We generally arrange the roundhouses so that we can get five or six stalls which can be used by the Mallet engines without having to swing the table, the turning of the engine being done with the wye."

Maintenance.

The maintenance of turntables may be easy or hard according to conditions. If proper care is used in the design and construction, the maintenance should not be difficult although it will necessitate frequent inspection and immediate correction of any defects that may be discovered. Constant war must be waged against the elements that tend to corrode the table and the Committee knows no other means of preventing corrosion than frequent cleaning and painting, patch painting when necessary. At least once each year and as much oftener as centers are submerged by floods or turn hard for any reason, the table should be jacked up and the center thoroughly cleaned and re-filled with oil. To facilitate this jacking many roads provide steel brackets riveted to the table and concrete foundation for the jacks on one diameter of the pit.

C. E. Smith,
C. H. Fake,
F. G. Jonah,
J. S. Berry,
A. S. Markley,

Committee.

TABULATION OF PRACTICE OF VARIOUS RAILROADS WITH REFERENCE TO TURNTABLES.

NAME OF ROAD	LENGTH OF STANDARD	TYPE	LOADING AND UNIT STRESSES	LOCKS for HOLDING RAILS IN LINE	POWER FOR TURNING.	MEANS TO FASTEN RAILS to PARAPET or CIRCLE WALL	APPROXIMATE COST.	CENTERS
A.T. & S.F. System. 10,206 Miles A.F. Robinson Bridge Engr.	85 ft. A few built 90 ft. to avoid the use of frogs. In 1896 we commenced building 60 ft. Tables. We used these about 2 years and then went to 75 ft. The 75 ft. lgth. lasted less than 1 year. When the new engines forced us up to 85 ft. Tables.	Through tables entirely as they give the shallowest pit. Nearly all of our tables are located relatively close to the high water elevation and as a result shallow pits are desired. We have not built any deck tables in the last 16 years.	Our tables have been designed for the heaviest engines we have on the road. 60 ft. table, 139 ton engine. 75 ft. table consolidated engine with 200,000 lbs. on drivers and also Mikado engine. Our latest 85 ft. table was designed for our heaviest 5-ft type engines which weigh 243 tons, base-total 77'-10". 8000 lbs. net tension and 4000 lbs. gross shear. Web plates in main girders never less than ½ in. Use low unit stresses in order to keep the deflection as small as possible.	Forging in the shape of the letter "I." This slips in between the webs of the rail on the table and in the approach tracks.	Twelve years ago we obtained an appropriation of $500 with which to experiment with turn table tractors. Shortly after we placed an order for 20 Totlow motors and later 5 or 6 more. These air motors will work satisfactorily if proper care is exercised in the arrangement of the drainage to prevent freezing. The motor is not fool-proof, but it has given good service on our lines. As the power on the system increased in weight and as we installed electric power plants at our machine shops we gradually went into the use of electric motors. At the present time all of the above air motors are in service and about 25 electric motors.	The rails in radial tracks are spiked to a timber wall on top of the circle wall. The circle rail in the pit is laid on sawed ties which rest on concrete and the rail is spiked to these ties.	The standard 85 ft. table, equipped with electric motor will cost close to $11,000 ready for use. Motor, $1,400, substructure $3,500. A table designed for handling our largest Mallet engines, balancing the load when turning, would have to have a pit from 125 ft. to 136 ft. in diameter. This table would cost as much as $20,000, complete ready for service.	We have always used our own standard centers. While disc bearings work very well the writer never succeeded in getting out one that gave prospect of long life and easy turning.
Baltimore & Ohio System. 4,724 Miles. F.L. Stuart, Ch. Engr.	80 ft. turn table with end carriages for ordinary road engines of the Pacific or Mikado type. At points where it is necessary to turn Mallet engines we are using 100 ft. table with end carriages.	No through tables. All of our tables are so located that pits for deck tables can be properly drained.	Our more recent 80' tables are being designed for Mikado engines weighing 275 000 lbs. and the 100' tables we now have under consideration are being designed for 460 000 Mallet engines. Unit strains for flanges 10 000 lbs. per sq. in. shear, 6326 lbs. sq. in.	None.	Where electric power is available we use an electric tractor. Otherwise air motors are used, except at points where turntables are infrequently used.	Approach rails spiked to coping timber. Circle rail spiked to short ties. Coping timber and ties rest on concrete circle wall which is set on piles where necessary.	Our standard 80 ft. turntable with end carriage and electric tractor. Complete, costs in the neighborhood of $7,500.	With the heavier loads occasioned by the turning of modern engines we consider centers with conical rollers the best type. This is primarily due to the fact that the radius of the bearing area of a conical roller center is larger than would be provided by a disc center and the shifting of the center of gravity of the load, due to the tipping of the tables, has less effect on the bearings.
Bessemer & Lake Erie Railroad. H.T. Porter. Ch. Engr. 269 Miles.	80 ft.	All deck girders.	Coopers E.60 loading. Stresses according to specifications of the American Railway Engineering Association.	Slotted casting on ties between rails of each track leading from the table. Latch operated by hand.	Three of our tables operated by electric power. Would use no other unless electricity could not be obtained.	Approach rails bear on a 1 in. plate resting on timber top of parapet wall. ¾" lag screws and clips hold approach rails and pit rails down. Pit rail rests on 7"x9" ties laid flat and concreted in. Parapet timber and ties supported by concrete circle wall 6'-7" inside on firm foundation or 8'-4" wide on piles.	80 ft. table complete as follows: Excavn. and foundn. $3000. Table with center $3,000. = ... $6000. Coping, ties & floor, ... 600. Rail, rail & fastings, ... 200. 20 H.P. elec. tractor, .. 1500. Miscellaneous, ... 200. Total, ... $8,500.	All conical roller centers. Latest type Am. Bridge Company standard.
Boston & Maine R.R. 2,351 Miles. A.B. Corthell. Ch. Engr.	75 ft. but are considering 80' standard. Sometimes we add length to accommodate frogs in approach tracks.	Deck girders.	Coopers E-50, stressed according to specifications of the Am. Ry. Eng. Association.	2"x 3" plank shod with iron at ends to slide between webs of rails at ends of turntables.	We use power at all important points. Have installed many gasoline motors but are changing to electric motors wherever electric current can be obtained.	Approach rails on timber coping. Circle rails on ties. Coping and ties on concrete circle wall. In some new installations rails rest on steel plates on concrete and are held down by anchor bolts and clips.	No reply.	Disc Centers.

Boston & Albany R.R. 392 Miles. W.F. Steffens, Engr. Structures	85 ft. long.	All deck girders as we have not been limited by drainage conditions.	Same axle loads as Cooper's E-60 but with axle spacing increased a total of 10 ft. to get greater bending moment at center.	No reply	We use wherever possible electric motors, as this is an ideal form of power. In a number of installations we have gasolene motors of the type generally used for turntables. At some isolated places, where not convenient for electric motors, nor economical to install gasolene motors, we use air motors of the type made by the Pilling Co.	Face of circle formed by 10" I Beams curbed and anchored to concrete. Ends of apch. rails attached to I beam by bolts through rail & beam flgs. Circle rail rests on steel plates 6"x½"x12" every 3 ft. and held down by anchor bolts set in concrete & clips. Conc. circle wall 6'-6" wide at base rests on 2 rows of piles 3' c. to c. in each row where nec'y. In some cases where the installation is likely to be changed we have used timber circle wall.	85' Tables weigh about 88,000 lbs. Cost about $3,500. in place. Complete installation in place of old table costs between $5,000. and 6,000 making a total of $8,500 to $9,500	Heavy type of centers by Am. Bridge Co. Has conical rollers 10" long.
Buffalo Rochester & Pittsbgh Ry. 568 Miles E.F. Robinson Ch. Engr.	65'-70'-75'-80' We have no Std. length of tables, the length being determined by operating conditions. The 80 ft. table was placed to accommodate decapod pusher engines. Now putting in 90 ft. tables.	Deck Girders	Cooper's E-60 16,000 lbs. sq. in. in tension, 10,000 lbs. in shear.	Sliding "T" bars engaging webs of spider rails.	Electric tractors	Rails are secured by bolts and bevel washers to channel irons set in concrete coping in later designs.	No reply.	Conical roller bearings used entirely and have always given satisfaction.
Central of Georgia Ry. 1915 Miles. C.K. Lawrence Ch. Engr.	80 ft.	Deck plate girders only have been used. Should drainage condns require it we would use thru plate girders.	Cooper's E-55 Tension 8,000 $(1+\frac{Min.}{Max.})$ shearing pins and rivets 7500. Pl. Gir. web 6000. Bearing 15000.	Use I shaped bar at ends of table rails.	Power other than hand power is used only where a large number of engines are turned daily. Where other power is necessary electricity is preferred.	Apch. rails rest on coping timbers on Conc. circ. wall, Circ. rail buried in Conc. cir. wall up to bottom of its head. In conc. under circ. rail are 3 pc. (2' long) old rail under position of trailing wheels when table is set for main leads.	Table .... $2,100 Pit & drainage, .. 2,280 Floor, timber, curb, etc, ... 350 Rail fastenings, 135 Installing, ... 235 Total, ... $5,100	Conical roller centers.
Central R.R. of New Jersey. 670 Miles. J.O. Osgood. Ch. Engr.	80 ft.	Deck tables wherever practicable. Thru girders have been used at tidewater where impracticable to get drainage for deck tables.	Cooper's E-55 Stress accord'g. to specifications of Am. Ry. Eng. Assn. with full impact allowance.	Sliding tongue on top of ties working in cylinders and operated by a lever which also opr. dwarf semaphore sig. on top of girders,—at congested points where power is used. No locks where operated by hand.	Elec. power at busy terminals. At other points where electr'y. is not available air motors are used,—air supplied from locomotives. Elec. power most reliable.	Apch. and circular rails supported on castgs. on concrete circle wall. Conc. under apch. tracks, reinforced by 2 rails 12' long ea. embedded upside down with flanges level with top surf. of Conc.	8230 lbs. Steel, $2,677 Center in place .. 600 Pit .... 5,000 Total, $8,277. Rollers without spider have tendency to crowd out of position and bind, causing table to turn hard under heavy loads. Esp. noticeable if used a year & rollers become worn.	Trade centers. Our Std. prac. is conical roller bearing C. with spider for keeping rollers to true positn.
C. & O. Ry. 1938 Mi. F.I. Cabell, Ch. Engr.	70'-85' and 100'	Deck girders	Mal. Compound, 2:8:8:0 type, 623,000 lbs. 78 ft. wheel base, 10,000 lbs. sq. in for negative moment, 12,000 lbs. for pos. mom. 6,000 shear. No impact.	Loose toggle sliding against rail webs connected by a connecting bar.	Compressed air tractors.	Apch. rails spiked to timber wall plates and circ. rail spiked to short ties embedded in conc. Both supported on conc.	85' table costs $8,000. 100' " " 10,000.	Mfrs. Std. centers with conical rollers without ball bearings.
C. & A. R.R. 1216 Miles. E.L. Crugar. Asst. Ch. Engr.	90 ft.	Both deck and through girders.	Mikado type equiv. to E-60 Cooper's. 10,000 lbs. sq. in. in tensn. 6000 " " " shear.	Latch consts. of a hinged bar att. to table which engags. a socket att. to the circ	On large tables air or electricity.	Apch. rails rest on coping timber. Circle rail rests on ties. Both on conc. circle rail.	No information	No standard center. Use a good type of con. roller bearing ctr. with live ring.
Chicago & Northwest'rn Railway. 9686 Mi. E.C. Carter, Ch. Engr.	All tables installed last 5 years are 80 ft. long	Deck girders.	No standards except as obtained from manufacturers.	Latch of iron bar with lugs at end sliding between webs of rails.	14 tables air 10 " electricity 1 " gasolene Electricity has proved very satisfactory, and have been put in at all points where we generate our own power.	Approach rails spiked to coping timber. Circle rail attached to ties embedded in concrete circle wall.	Steel work in 1911, $2600 Pit complete, 2,200 well with small tables handling light engines. Tables handling very heavy power operate better with conical roller bearing centers.	Trade centers. Our experience with disc bearing ctrs. has been that they operate very

ROAD	LENGTH	TYPE	LOADING, &c.	LOCKS	POWER	RAIL FASTENINGS	COST	CENTERS
C. & E. I. R. R. 966 Mi. L. C. Hartley Ch. Engr.	Lengths vary 65 to 75 ft. Do not have std. tables.	Mostly deck girder type. Thru girders where shallow pit desired.	200 tons	None	Air and electric power both giving good satisfaction.	Apch. rails fastened to coping timber. Circ. rail fastnd. to ties in some cases and rest on steel plates in others. Circle wall of concrete.	No information	Trade Centers.
C. B. & Q. R. R. 8,966 Mi. L. J. Hotchkiss Asst. Br. Engr.	70', 75', 80' Deck 80' through. Lgth. made to suit class of engines turned at dif. points.	Deck up to 80' lengths. Have a few thru truss tables where shallow floor is required.	Trade standards for 200 ton engn. CB&Q design of thru table for Mikado 426,850 lbs. Tension 16,000 lbs. sq. in. on parts not affecting deflection. 9,000 lbs. sq. in. on members affecting deflection.	None.	Gasolene power except at a few points where elec. current is available at low rates, and a few air tractors	Apch. rails rest on coping timber. Circ. rail rests directly on Concrete circle wall.	No figures at hand	Trade standards as a rule. Now designing our own. Conical roller bearing will not stand up under heavy power. Disc bearings in use 3 years and so far entirely satisfactory.
C. G. W. R. R. 1496 Mi. L. C. Fritch Ch. Engr.	90 ft.	Deck.	Cooper's E-55	Ordinary Sliding Latch.	Electric tractors where current is available.	Rail anchors.	Table Complete $4,960. Deck .... 400 Elec. tractor .... 900 Concrete Pit .... 4,500 Total $10,760	Trade centers with conical roller bearing centers.
C. I. & L. Ry. 615 Mi. A. S. Kent Eng. M. of W.	80 ft.	Deck except where drainage is insufficient.	Mikado type, 240 tons.	None.	Expect to install electric motors at important points this season.	Rails rest on timbers embedded in concrete circle wall.	No reply.	Trade centers
C. M. & P. S. Ry. 1803 Miles. E. O. Reeder Ch. Engr.	85 ft. except in a few cases where we are now installing 105 ft. tables to take care of Mallet engi.	For 85 ft. we use deck or thru depending on drainage. For 105 ft. we use pony trusses	300 tons.	End latches.	In most cases turned by hand. In one or two instances use air.	Apch. rails rest on coping timbers. Circle rail rests on short ties.	Three classes of construction for 85 ft. tables. First class const. assumes concrete center and circle wall. Deck $10,630. Thru, $12,430. Half thru, $10,900. Second class, concrete center, conc. circulr. rail support and timber back wall. Deck $10,330. Thru, $11,875. Half thru, $10,475. Third class, Conc. center, pile circular rail support and timber back wall. Deck, $8,570. Thru, $10,080. Half thru, $8,800.	Spl. std. conical roller bearing ctr. with ball bearings. Tried only one disc bearing ctr. which was not at all satisfactory and had to be removed.
C. M. & St. P. Ry. 7,481 Miles. C. F. Loweth Ch. Engr.	Are ordering no new tables less than 90 ft.	Prefer deck but conditions have arisen where we have put in half thru and pony truss tables. Decks preferred, simpler and less expensive.	90 ft. tables for 250 ton locomotives.	Usually a hand latch, altho in a number of cases it is operated by the man in charge of the motor.	Power used at the larger tables.	Approach rails spiked to timber coping.	Not available.	Our own design of center which has conical roller bearing center with ball bearing deck and thrust. We have had some experience with disc centers which were not satisfactory.
C. C. C. & St. L. Ry. 2,385 Miles G. P. Smith Ch. Engr.	85 ft.	Deck	225 tons	Latch attached to girders and engages a socket in the wall. Where tables are turned by tractors latch is unnecessary and seldom used.	Power tractors on all heavy and busy tables. Both electric and air but prefer electric. Air motors unsatisfactory acct. of freezing in cold weather.	Apch. and cir. rails rest on 3/4" steel plates bedded in conc. 20" ctrs. At main trks. the circ. rail is carried on curved 12" I bms. 20' long bedded in Conc. on pcs. of rails 2'-6" long every 3'. Similar arr. should be used for Apch. rails at main points as the 3/4" plates not adequate.	80 ft. table $4,000 Pit .... 5,000 Total, $9,000	Disc ctrs. are std. Have used trade stds. in tables less than 85' long. Our experience with disc ctr. not extensive but its advtgs. in maint. will more than offset greater power to turn. Con. roll. bearing too small for loads and cost of maint. exc.

C.R.I.&P. Ry. 8,020 Mi. I.L.Simmons Br. Engr.	75 ft. We are contemplating using a 90 ft. table, owing to increase in power.	Standard, Deck. Will use two different depths Shallow type where drainage requires.	200 tons. 10,000 lbs. per sq. in. tension. 6,000 lbs. Shear.	None.	Air motors. We do not find them very satisfactory on acct. of the motors freezing up in our Northern territory. In the future will probably use electricity where current is easily obtained.	Approach rail spiked to timber coping. Circle rail set on concrete and held by anchor bolts.	75 ft. table costs $7,500 90 ft. table will cost about $9,000.	Trade centers.
C.St.P.M. & O.Ry. 1744 Mi. C.W.Johnson Ch. Engr.	80 ft. up to date. This year increased to 90 ft.	Deck, except when drainage conditions compel use of thru. table	200 tons.	Sliding latch on top of ties bet. webs of rails operated by hand lever.	Air and electric. Favor latter where it is easily obtained.	Apch. rails rest on coping timber. Circle rail set on concrete.	80 ft. table, inspn., frt., etc., ... $2,720. Setting, ... 169. Foundn. ties, etc., 1,831. Total, $4,720. Cost does not inc. piles.	Trade Standards.
C.& S. Ry. 1,248 Miles. W.H.Cowan Ch. Engr.	Longest table, 80 ft. Would recommend 90 ft.	Both, deck and thru. Latter where drainage conditions demand.	200 tons.	Lock thrown by lever.	All tables turned by electricity or air. Prefer electric.	Cast chairs spiked to timber coping for apch. rails. Circ. rails on tie plates, and timber ties set in concrete.	80 ft. table, $3,300. Pit, ... 2,500. Total, $5,860.	Trade Standards, conical roller bearings.
D.&H. Co. 843 Mi. G.H.Burgess Ch. Engr.	60 to 90 ft.	Deck except where drainage Condns. compel use of thru.	Cooper's E-60. Tension 8,000# per sq. in.	None.	Electricity where obtainable. At other places air. On branch lines where light power is used, turn by hand. Electric most satisfactory.	Apch. rails rest in riv. steel plate chairs anchd. to the conc. Circle rail rests on timber ties bedded in conc. or rests directly on concrete.	90' table; foundn. pit and walls, ... $5,000 Table, ... 3,500 Installation, ... 150 Tractor, ... 1,200 Total, $9,850	Trade standard: Conical roller bearings.
D.L.& W. R.R. 972 Miles G.J.Ray Ch. Engr.	90 ft.	Deck pl. gir. except where drainage condns. compel the use of through.	Tension 10,000 lbs. sq. in. Shear 6,000 lbs. sq. in.	All have locks.	Electricity or air. Air used only where electricity is not available.	Apch. and circ. rails rest directly on conc. circ. rails and are held by anchor bolts set in Conc. Parapet wall under approach rails reinforced by 2 curved rails embed upright in Conc.	No information.	Roller bearing centers.
D.& R.G. R.R. 2,778 Mi. J.G.Gwyn. Ch. Engr.	80 ft. Standard. Only 90' tables used for turning Mallet engs.	Deck. Have a few through tables where drainage condns. demand.	Same as bridge specifications.	Locks not genrlly. used, but when used are bars sliding bet. webs of rails.	Where elec. can be cheaply secured we use it. At outlying pts. air is used being obtaind. from air compsr. or loco.	Apch. rails spiked to coping timber. Circle rail to short ties embedded in concrete.	No information.	Trade standard conical roller bearing centers.
E.J.& E. Ry. 482 Mi. A.Montzheimer Ch. Engr.	80 ft.	Deck	200 ton Stresses conform with specifications of Am. Ry. Eng. Assn.	No locks. The motors and gears hold the table in line. Motors equipped with brakes.	Electric. Recom. overhead collector rings as have had trouble from wires placed underground acct. dampness causing short circuits. Also from ice.	All circle and apch. rails rest on conc. and are held down by bolts set in drilled holes.	80 ft. table $6,500. Complete.	Am. Br. Co's. Conical roller bearing center.
ERIE R.R. 2,511 Mi. F.A.Howard, Engr. B.&B.	80 ft. Contemplating the construction of longer and heavier tables, up to 90' or 100'.	Deck plate girders.	Mallet engine with 6 drivers 55,000 lbs. on ea. 12,000 lbs. flange stress per sq. in. no impact.	Bar with lugs at ends slides bet. webs of rails. In a few cases a toggle pin has been used.	Nearly all turned by power. Electricity has been best; next to this gasolene engines.	Approach and circle rails are spiked to the ties.	80 ft. table: Pit, ... $5,000 Table, ... 3,000 Center, ... 500 Total, .. $8,500	King Br. Co. conical roller bearg. center with ball bearings at ends of con. rollrs. Trouble with balls; Substitg. discs at end of con. rollers.

ROAD	LENGTH	TYPE	LOADING, &c.	LOCKS	POWER	RAIL FASTENINGS.	COST	CENTERS.
GRAND TRUNK RY. SYS. 4,757 Mi. N. K. Safford Ch. Engr.	80 ft. One of 100 ft. to accommodate Roundhouse of 60 stalls.	Through girders.	No Information	None.	Air motor or electric power.	Apch. rails spiked to coping timber and circle rails to ties embedded in concrete.	Table, ... $3,900 Pit, ... 2,100 Total, ... $6,000	Ball bearing centers. 56 two in. balls.
G. N. Ry. 7,274 Mi. A. H. Hogeland, Ch. Engr.	80' and 92'. Desired to get them long enough to balance locomotive.	Thru pl. Girders. Decks require too much excavn. Thru gr. trussed to C. H. tower.	80 ft. 180 tons. 92' table 258 ton Mallet; 12,000 lbs. sq. in. tension for 80' and 12,000 lbs. sq. in for 92'. No impact	Plunger thrown by hand engages socket in circle wall below deck.	Air, elec. and gaso. motors. Gasolene used only where the others not available acct. increased fire risk.	Approach rails spiked to timber coping and circle rail to timber ties.	80', complete, . $7,900. 92', " ... 9,700.	Trade standards with conical rollers.
Ill. Central R. R. 2,245 Miles. A. S. Baldwin, Ch. Engr.	85 and 75 ft. 85' at main line points and other places where required. 75 ft. on branch lines	Deck plate girders.	200 tons.	Std. plan requires no locks. At some points locks consist of a latch on table that drops into a chair on wall.	Elec. where current can be obtained economically. Air in other cases. Air gives trouble in cold weather unless all pipes and connections are under ground.	Apch. rails spiked to timber coping. Circle rail rests on concrete held down by clips and anchor bolts.	85 ft.: Steel, ... $3,500 Excv. wall, ctr. & rails, 3,200 Pile foundation, ... 1,200 Paving ...... 850 Total, 8,750 75 ft.: Steel $3000; Excv. curb wall, ctr. and rails $2,000; pile foundn. $1050; paving $950. Total, $6,750.	Conical roller bearing ctr. with ball bearings.
INTERCOLONIAL RY. OF CAN. 1,499 MI. Wm. B. Mackenzie Ch. Engr.	75 ft.	Through tables altogether in new work.	200 Tons Tension 8,000 lbs per sq. in.	Bar which engages in a slot.	Hand power only.	Apch. rails spiked to timber coping. Circle rail to timber ties on concrete circle wall.	75 ft. Table. Pit, ... $3,200 Table, ... 4,500 Total, ... $7,700	Ball bearing ctr. Have had some good conical roller bearings, and some failed by flattening.
I. & G. N. RY. 1,106 Miles. O. H. Crittenden, Ch. Engr.	75 ft.	Half through girders.	200 tons.	None.	Air tractors.	Apch. rails spiked to coping timber. Flanges notched for spikes for 30 ft. from circle wall. Circle rails spiked to short ties embedded in concrete.	Table complete, $3,850 Tractor, ... 500 Foundations, ... 1,150 Total, $5,500	Conical rollers.
K. C. S. RY. 833 Miles. C. E. Johnston, Ch. Engr.	90 ft.	Deck girders.	240 ton Mallet locomotive. 12,000 lbs. per sq. in tension and Compression.	We use a bar which is dropped over engaging the rails to hold table in line with tracks.	Air tractors	Apch. rails att. to coping timber with screw spikes. Tie plates used. Circ. rail att. to short creosoted ties by screw spikes.	90 ft. complete, $9,500	Am. Br. Cos. Std. Conical roller bearing center.
L. S. & M. S. RY. 1,663 Miles. S. Rockwell, Ch. Engr.	85 ft.	Deck girders.	210 tons. 10 wheel Sw. locomotives 11,000 lbs. sq. in. tension. 7,500 lbs sq. in. Shear.	Rail lock operated by hand lever.	All newly installed tables equipped with elec. tractors where it is pos. to obtain current.	Apch. rails spkd. to coping timber. Circle rail fastnd. directly to concrete by bolts and clips.	Table costs about $3,200; complete installation from $6,600 to $8,000.	King Br. Co's. std. Conical roller bearing center with ball bearings at ends of rollers.
Lehigh Valley R. R. 1432 Miles. E. B. Ashby. Ch. Engr.	80 ft.	Deck girders.	Coopers E-60. Stresses accdg. to Am. Ry. Eng. Assn. with full impact.	Locks and sigs provided at all important points; at other pts. I shaped bars; sliding bolt engages socket in circle wall. Driven by spring; withdrawn by cable.	Elec. where available. Next in pref. gasolene motor; Then air motor.	Apch. rail spiked to timber coping. Cir. rail att. to short ties on circle wall.	80 ft. table, ... $3,880 Masy. full pit, ... 3,660 Drainage, ... 800 Circ. track, ... 300 Sundries, ... 60 Total, ... $8,700	Trade ctr. with con. rollers and live ring. All con. rollers are ptd. with indpdt. bearings. Discs not satisfac. acct. heavy pres. plus proper lubrication.
Long Island R. R. 392 Miles. J. R. Savage. Ch. Engr.	80 ft.	Deck girders.	Coopers E-50. 16,000 lbs. sq. in. tension. 10,000 lbs. shear	Toggle bar bet. a pair of angles.	Gasolene for tables operated frequently. Others air.	Apch. rail spiked to coping timber. Circle rail spiked to short ties emb. in concrete.	80' table, ... $2,600 Erection, ... 180 Ctr. wall trk, ... 1,735 Deck, etc., ... [illegible] Total, ... $4,980	Conical roller bearings with live ring.

L.&N.R.R. 4,590 Miles. W.H.Courtenay Ch. Engr.	85 ft.	Deck girders preferred. Thru girders used only when impos. to secure clge for deks.	192 tons with impact. Tension 15,000 lbs. per sq. in.	Rail Lock consists of flat I shaped bar worked by hand.	Elec. tractors where current can be obtained. No other power has been used.	Approach rails spiked to coping timber. Circ. rails spiked to short ties embd. in concrete.	No information.	Trade standards. Conical roller bearing ctrs. without ball bearings. Disc. ctr. not satisfcy.
Maine Cent. R.R. 932 Miles. T.L. Dunn. Ch. Engr.	80 ft.	Deck girders except one through.	Cooper's E-50. 10,000 lbs. sq. in. web shear 7,500 sq. in.	Tables turned by power held in place by brake on engine. Others by latch eng. a socket in pit wall.	Electric power used on some tables. Others turned by hand.	Rails held to circle wall by cast iron clips and bolts.	80 ft. table, ... $8.300	Disc center, per N.Y.C. standard.
M.&St.L.R.R. 1,610 Miles. R.G. Kenley. Ch. Engr.	70 ft. Need 75 or 80 ft. to bal. our heaviest engs. with tenders empty.	Deck and Thru. Latter where cost of deck pit too expensive as solid rock, or dif. to drain.	152 ton engines 8,000 lbs. sq. in net section.	Yoke design for end latch to hold table in line. Latch operated by hand.	One table operated by air.	Apch. rails spiked to coping timber. Circ. rails spiked to short ties restg. on Conc. circle wall.	70 ft. table. Deck, ... $6,570 Through, ... 6,500	Trade standard Conical roller bearing centers.
Mo. Pac. Ry. System. 7236 Miles. C.E. Smith. Bridge Engr.	75 ft. Future tables should be longer.	Deck girders.	200 tons. 10,000 lbs. per sq. in.	Sliding I shaped bar between webs of rails, op. by hand.	Use electricity, gasolene, and air on a few tables only.	Apch. rails spiked to tim. coping. Circ. rail spiked to short ties on conc. wall in some cases. In many cases pile and tim. walls used in place of concrete.	75 ft. complete with tim. wall and cinder pav. $4,500 With concrete wall and brick paving, ... $6,000	Trade standards with conical rollers with ball bearings when we can get them.
M.&O.R.R. 925 Miles. B.A. Wood, Ch. Eng. Maint.	75 ft. Expect to inc. length of std. to 80 ft.	Deck girders.	Cooper's E-55. with stresses of Am. Ry. Eng. Assn.	Movable Iron Clamp.	Gasolene engines on 75 ft. tables. Others turned by hand.	Apch. rails to coping timber. Circle rail to short ties.	75 ft. table, ... $2,250 Pit and installn, ... 2,250 Gasolene motor, ... 1,250 Total, ... $5,750	Conical roller bearing centers.
N.C.&St.L. Ry. 1,230 Miles. H. McDonald, Ch. Engr.	90 ft. dollars to avoid through tables.	Deck girders; would go to great expense, say 3 to 4 thousand	Spl. E-60 loading with stresses of Am. Ry. Eng. Assn.	Lock used only on tables turned by hand.	Electric tractor, which gives good satisfaction.	Apch. and circular rails attached directly to Concrete by steel clips and bolts.	Excavation, ... $1,000 Concrete, ... 2,500 Circle rail, ... 150 Table, ... 3,500 Floor $125, Tractor $1500 1,625 Total, ..$[illegible]	King Br. Co. and Am. Br. Cos. centers. Much prefer con. roller bearing centers.
National Rys of Mexico, 7,408 Mi. Jas. M. Reid, Ch. Engr.	75 ft. for ord. condns. and 80 ft. where Mallet comp. engs are used.	Deck Girders.	75 ft. table 200 tons. 80 ft. table, 254 Ton Mallet.	Latches are used.	Two tables turned by elec. motors. Others by hand.	Rails attached to timber coping and ties or to cast iron chairs.	75 ft. table at N.Y. $3,000 Freight, 900. Deck 300 or 1.200 Erec. & ptg, 400 Pit, 2500 80 ft. Table N.Y. $3,300, Painting, 450. Deck, 300. Total, $9,000. Total, $8,100. Frt, 950. Erec. & Pit, $4000	Trade centers with Conical roller bearings.
N.Y.C.&H.R. 3,381 Mi. G.W. Kittridge Ch. Engr.	85 ft.	Deck girders In cases where necessary a through or half thru is used.	246 ton Mallet engine. 10,000 lbs per. sq. in tension 7,500 lbs. sq. in. Shear.	Forged bar in the shape of I worked by hand.	Elec. where power is available. At other points gaso. engine Elec. for tractor is run up thru center.	Rim of circ. wall surmtd. by an 8 in.-48 lb. beam bent to circ. and bolted down. Apch. rail bolted to flange. Formerly rested on 2 curved rails embedded in conc. Circ. rail rests on short ties in some cases and on Conc. in others.	Deck table, .. $2,800 Through " ... 3.600 Pits for tables run from $3,000 to $8.000. Std. table complete, $6.000 to $11,000.	Disc. centers on rollers-high pedestal.
N.Y.N.H.&H. R.R. 2,047 Mi. E. Gagel, Ch. Engr.	75 ft. std. Some 80 ft. tables have been built.	Deck girders. Where necy. we use through girders.	190 ton Pacific type. Am. Ry. Eng. Assn. stresses.	A forged hinged lock placed in the center of the track.	Power is used at all busy points. Electy. is used where available. Otherwise we generally use gasolene engines.	No information.	Deck type, av. . $6.800 Through " " .. 9.300 Tractor, ... 1,000	King Br. Cos. or Am. Br. Cos. Standard conical roller bearing ctr. with either ball or bronze thrust brgs.

ROAD	LENGTH	TYPE	LOADING &c.	LOCKS	POWER	RAIL FASTENINGS	COST	CENTERS
Norfolk & Western. 1,951 Miles. C.S. Churchill Ch. Engr.	100 ft.	Through girders with std. floor sys. on acct. of depth of pit and drainage.	9000 lbs. per lin. ft., one arm loaded. 7000 lbs. per lin. ft. both arms loaded. 10,000 lbs. per sq. in., no impact.	Tractors have brakes which hold table in line.	When electric power is available we prefer electric tractors	Approach rails spiked to coping timbers. Circle rail spiked to short ties on concrete wall.	100 ft table, . . $5,000 Pits vary from 5,000 to $10,000	Heaviest trade standard, Conical roller type
Nor. Pac. Ry. 6,019 Miles W.L. Darling. Ch. Engr.	85 ft.	Thru. girders with standard floor. 3'-7" to top of center concrete.	219½ ton engine 8,000 lbs. per sq. in.	Locks used.	Air and electric. Prefer electricity where available.	Approach rails on coping timber. Circle rails spiked to short ties on concrete wall.	No information	Standard conical roller bearings.
O.S.L.R.R. 1646 Miles C. Stradley Asst. Gen. Mgr.	80 ft. Since the advent of the Mallet eng. necy. to put in some 100 ft.	80 ft. Deck 100 ft. table is a pony riv. Warren truss.	192½ ton consolidation.	Tractor brake holds in line.	Electric power in all cases.	No information.	Tables 66' to 100' long have varied in price from $6,000 to $25,000	Standard center with conical rollers.
O.-W. R.R. & Nav. Co. 1,883 Miles G.W. Boschke Gen. Mgr.	80 ft.	Deck girders	192½ ton consolidation.	Use tumbler and drop with a guide at each end.	Use either air or electricity wherever we have shops.	Approach rails spiked to coping timber.	Weight, 72,000 lbs. Cost, . . $8,000	Conical roller center with live ring.
P.R.R. 5,554 Miles H.R. Leonard, Eng. B.&B.	85' and 100' Latter used to avoid frogs.	Deck girders. Pit 11'-3" to top of catch basin grating for 100' table.	226 ton Pacific type. 16,000 lbs per sq. in.	No standard device.	Majority operated by power, principally electric.	Approach rails spiked to oak coping timber. Circle rail to short ties on concrete circle wall.	No information	Conical roller bearing center.
Pa. Lines W. of Pgh. 2,889 Miles. J.C. Bland Engr. of Brs.	75 ft. for minor lines. 85 ft. for main lines.	Deck tables.	Computed for heaviest engines existing and regular bridge stresses.	No information.	No information	Approach rails spiked to coping timber. Circle rail spiked to short ties on concrete wall.	No information	King Bridge Co's. Standard conical roller bearings with ball bearing ends.
P.& R. Ry. 1,509 Mi. Wm. Hunter, Ch. Engr.	75 ft. standard. One table 85 ft.	Deck and through, depending on drainage conditions.	Cooper's E-55 about 10,000 lbs per sq. in. no impact.	Tongue slides in groove on table and engages chair on circle.	Motors on tables having a large amt. of work to do. Elec. or Gasa. as may be convenient.	Apch. rails spiked to coping timber. Circ. rail rests on C.I. chairs, and held down by clips and bolts on concrete wall.	About $4,500, exclusive of foundations and motors.	Conical roller center.
P.& L.E.R.R. 215 Miles. J.A. Atwood Ch. Engr.	90 ft. for future construction.	Deck girders.	Stresses not over 12,000 lbs. sq. in. End deflection under live load not to exceed ½"	None.	Electric tractor at important points.	Rails spiked to timber ties.	Foundations, . . . $2,167 Table, ... 2,067 Deck, ... 520 Fastenings, ... 67 Total, . . $4,821.	Trade standards Conical rollers have given good service.

St. L. & S. F. R. R. 4,732 Mi. M. C. Byers, Ch. Eng. Opn.	75 ft. for the last 10 years. Will probably install 90 ft. from now on. May install a few 100 or 110 ft. for Mallet locomotives.	Deck plate girders up to date. May possibly use a through table for Mallet engines.	For 85 ft. table are using E-55, also spl. loading to cover longest Pacific and Mikado locomotives. 50% impact in main girders. 100% in end trucks. 10,000 lbs. per sq. in. in tension. Do for shear.	Not generally provided as former latches were not used by workmen.	Totlow air motors on all tables where air is available.	Apch. rails spiked to coping timber. Circle rails rest on—and partly embedded in concrete circle wall.	75 ft. table, ... $2.500 Setting........ 500 Pit,.......... 3,500 Total, ... $6.500	Trade standard centers; principally King Bridge Co's. conical roller center with ball bearings. Have some disc bearing ctrs. in use 15 years and in good condition.
Seaboard Air Line Ry. 3,008 Miles. W. L. Seddon, Ch. Engr.	85 ft.	Deck plate girders. Would use through table if necessary to get drainage.	Engine of equiv. wt. to Cooper's E-50, but 50% longer. 10,000 lbs. per sq. in.	Hand operated tables locked with bar between rails. Others are held by brake on tractor.	All tables 75 ft. long or over are operated by power. Usually gasolene, but electric power preferred.	Apch. rails rest on coping timber. Circle rail on short ties embedded in concrete of circle wall.	Table,........ $2,000 Motor,.......... 1,100 Pit, in hard clay, 5,846 Total, ... $8,946 This will vary according to conditions.	Trade conical roller bearing centers.
Southern Ry. 7,039 Mi. B. Herman, Ch. Engr. M. of W. & S.	Latest table 90 ft. long to turn Mallet engines.	Deck girders.	263 ton Mallet engine. 10,000 lbs. per sq. in. no impact.	Sliding latch against web of rails.	All tables much used equipped with power. Prefer electric where available. Next preference is air from shop or locomotive in latter case using an accumulator. Have had good success with the Mc. Grath air motor. Have also used steam and gasolene with good results.	Approach rails spiked to timber coping. Circle rail spiked to short ties embedded in concrete of circle wall.	No information.	Trade standards conical roller bearings.
U. P. R. R. 3,507 Mi. R. L. Huntley, Asst. Gen. Mgr.	80 to 100 ft. Latter required to turn Mallet engines.	Deck girders for 80 ft. Pony trusses for 100 ft.	192½ ton engines for 80 ft. 307 ton Mallet for 100 ft. 10,000 lbs. sq. in. stress.	Where turned by hand movable bar is used bet. rails. Where power is used, depend on brake on tractor.	Hand power, ... 33 Air, ... 3 Electricity, ... 9	Apch. rails spiked to timber coping. Circle rail bedded in concrete with about ½ in. of head protruding.	No information.	Standard with conical rollers.
Wabash R. R. 2,515 Mi. A. O. Cunningham, Ch. Engr.	75 ft. Future tables should be longer.	Deck and through. Latter only where it is impossible to get drainage for deck pit.	200 ton consolidation and Pacific type engines.	None.	Where cheap electricity can be obtained this is most desirable power. Gasolene engines are satisfactory and air where weather conditions permit.	Approach rails spiked to timber coping. Circle rail spiked to short ties resting on concrete circle wall.	Pit and Foundns. . $3,360 Deck table, .. . 2,430 Rails, ... 685 Motor, ... 1,075 Total, ... $7,550	Trade standard with conical rollers. Disc center should prove satisfactory if properly designed.

DISCUSSION.

The President:—This report exhausts the subject very thoroughly and gives us a fund of information which is just what we need at this time. I hope we will have a thorough discussion of it. I will ask Mr. C. E. Smith, the chairman of the committee, to bring the subject before the meeting.

Mr. Smith:—Since this report was prepared, I have learned of a proposed engine called the Henderson Triplex, on which, I think, it is proposed to have three sets of drivers, instead of two; three complete engines under the boiler and tender, with six-wheel trucks. I expect that engine could be turned on a 175-ft. turntable, but I don't think that such a turntable should be built. Such an engine ought to be turned on a wye where there is plenty of room for it.

I hope that the convention will not think the subject has been covered. I think that you gentlemen who have had experience in maintaining turntables for a number of years, can bring before this convention more important information than is given in this bulletin. Personally, I would like to hear a thorough discussion on it.

The President:—This subject has certainly been ably presented in the report and I hope that every member will take part in the discussion, to give all the facts and experience he may have had to the convention.

Mr. Pickering:—I am not in favor of the disc center. I have had some rather unpleasant experiences with them; in fact, all of the turntables above 60 ft. in length that I have on my division have disc centers. All of them, with one exception, are turned by gasoline power. We have had great difficulty in maintaining the gasoline engines. I questioned why we should have such difficulty, but I found that when the gasoline motor was out of order, it took from 10 to 15 men to turn our Pacific type engines on these tables, even after disconnecting the motor and I decided there must be some difficulty with the center. I had the centers very carefully examined, and I found that in almost every instance, they were not turning on the phosphor bronze center disc, but on the top of the follower cap, or the under side of the follower cap was turning on the top disc, with iron in contact with iron, or steel in contact with whatever the metal might be, although it is usually steel.

I installed a 75 ft. table early this year where there was comparatively little traffic, possibly 10 or 12 engines per day being the maximum number turned. It did not seem that we could afford to install power to turn it, as the conditions did not warrant this. We tried turning it by hand. Fortunately, we got the table installed possibly a week before the track was ready and the men reported that they could not turn the table. It was the same type of center that is illustrated in the report as the Missouri Pacific 1,000 ton draw bridge center. The men reported that it took six men to turn the empty table. I immediately decided that something must be done, because, if we got a Pacifie type of engine on that table there were not enough people in the village to turn it around. I consulted my division foreman and we decided to make a steel disc in two parts to take the place of this three-part disc center. The steel used was a low grade of tool steel, tempered to practically as hard a temper as it would take, which was not a brittle temper by any means. We installed this center and found that, instead of six men being required to turn the table, by using a good deal of effort, one man could swing it a quarter of the way around the circle and leave it and it would go four complete revolutions before it stopped. I took the matter up immediately with the builders of the turntable who were very anxious to find the difficulty. They sent their engineer from their works in Pennsylvania to see this table. As we were still in the experimental stage, to some extent, we took our steel center out and had their center in when the gentleman arrived. I invited him to turn the table, but he could not budge it with all the force he could apply, and he was quite a rugged man, too. At that time we had the track connected with the table and we put on three different classes of engines. The least number of men we could turn the engines with was six and it required eight men to turn the table with the heavier type of engine just mentioned, weighing 110 tons and they had to work hard. I did not time them accurately, but it required not less than four minutes to turn one of this class of engines with eight men. We tried this to his satisfaction, then removed that disc while he was there and put in our steel disc and two men turned our heavest type of engine, easily. This was quite a revelation to the engineer, as it had been to me, and he tried to get me to account for it, but I thought that was for him to determine. He requested me to return the phosphor bronze discs

to their works for regrinding, which I did. In fact, I returned two of the phosphor bronze discs with the steel upper and under discs which were sent back to me after refitting. One of them worked fairly well and six men would turn a Pacific type engine with comparative ease. We have continued the use of this steel disc to the present time and it has given splendid satisfaction. We have had no difficulty whatever with it. The other disc was no better than before and it was returned. The one which was retained was removed a short time ago and was found to be in perfect condition. The surface was very bright and smooth. It runs in an oil bath and apparently showed no signs of wear. One point I want to make against this steel disc as shown here is that there is a large hole through the center of the disc, the same as in the disc I mentioned; just so that there is a vacancy where the greatest bearing strain should come. This transfers the load outside of that center bearing point and the larger we make that bearing surface, the harder the table is going to turn. This gentleman tried to persuade me that the table turning hard was no material disadvantage where we had power to turn it, but I didn't take that argument very pleasantly. I think these centers should be designed to turn with the least amount of friction possible. I immediately decided in my own mind that the reason why the gasoline engines were giving so much trouble on the other tables was that they were simply overloaded. To turn the empty table was too much for them, to say nothing about turning a Pacific type engine.

I have a great many 60-ft. roller-bearing tables that turn our Atlantic type of engines, in fact, turn anything that has a wheel base short enough to get on the table, and I have no difficulty whatever with them. We plan to take the bearings out, clean them thoroughly and oil them once a year, and when this is done they give us no trouble and turn easily. I have none of that type of tables equipped for power turning as we find no difficulty in two or three men turning the largest type of engines that we can get on a 60 ft. table. I believe that the roller-bearing center is much preferable to the disc center.

Mr. Smith:—We have, or did have, until we took a few out some years ago—about forty of the old Union Bridge Co.'s 60 ft. tables on the Missouri-Pacific. They are supported by tall cast iron pedestals, over the top of which there are saddles. In the tops of the pedestals are what we call buttons as shown on the plan. This button is really a phosphor bronze disc about six inches

in diameter, as I remember it. We have never had any tables that turned any easier than those, until they were overloaded to the point where the pressure between the phosphor bronze and the steel got above 6,000 or 7,000 lbs. per sq. in. The oil then squeezed out from between the steel and the phosphor bronze, for there is no oil that will stand that pressure. As soon as we get metal on metal the phosphor bronze button cuts out rapidly and requires renewal and the turning of the surfaces on which it rests.

The matter of using a disc is entirely a matter of design. If it is properly designed and the pressure is kept low enough, say below 6,000 lbs. per sq. in., so that the oil will distribute itself between the discs and will not squeeze out, I think it is a very easy turning type of center.

Mr. Jutton:—There is one thing that has not been touched on yet in the discussion, and that is the paving. As I remember, the report states that paving depends on local conditions, and that it is hard to see where one secures a return on the money expended for paving in a turntable pit. I think that most turntables are neglected a great deal. They are allowed to get dirty and to rust and corrode. A dirty pit adds to that condition. It certainly adds a great deal to the appearance of a turntable and the surroundings in general to have the pit paved. One would not think of putting a pump or similar equipment below the surface of the ground and leaving the pumphouse with no paving, other than dirt or cinders but it is fixed up nicely and kept clean. When engines are moving on and off a turntable dripping water, cinders and all kinds of grease and oily waste collect. I find that after the man in charge of the table turns an engine he goes and sits down, lights his pipe and waits for the next engine. He don't see these little things that he might be doing in keeping the table clean and thereby preserving it. For that reason, we have to do something to keep the pits clean, if we can't control the men. I have thought that if some kind of a water tight covering,—say a plank covering,—could be put on the ties, all the dirt and grease would be caught on this top covering where it could be easily cleaned off and would not get to the metal. Carrying out the same idea, one would want a paving below. These two improvements would add considerable to the life of the metal. In addition, the table should be kept well painted.

I think we have two or three tables on the Northwestern at which the pit is completely covered, probably on account of snow.

The men operating those tables seem to think they could not get along without that pit covering. I know the table at Escanaba, Mich., where we generally have a good deal of trouble in the winter time, is provided with a stove and the pit is covered over so that they keep the table warm in the winter time.

The committee cites a disc center for a drawbridge. A drawbridge has the rollers under the rim, in addition to the center, and the two work together in turning. Of course, one might say we have the same thing on a disc center turntable, but the rollers, instead of being at the center, to take up the side-tipping, are at the ends of the table. This matter of side-tipping in turntables is very serious and I should think it would be more so in a disc center, especially when a table is overloaded. In overloading an old table, one must keep it high enough so that the deflection will not bring too much bearing on the end rollers. Also if the table is high it allows of more side-tipping. Under those conditions it is hard to operate the table and one always has a great deal of trouble for that reason. I believe the committee recommends that the table should be of sufficient strength that the end rollers shall be only ¾ in. above the circle rail when the table is not loaded. With a deflection of ½ in. that would leave ¼ in. at each end. This would be impossible with an overloaded table, the deflection being a great deal more. In regard to these conical center roller-bearing turntables, Mr. Finley, our assistant chief engineer, has raised the point that the device to hold the live ring right in place should hold every roller where it belongs, because the instant one of those conical rollers is displaced, there is no bearing on it and the pressure is correspondingly increased on all the others. In his opinion, that is something that should be looked after carefully. The photographs in the report, showing the standard roller centers of the Chicago, Milwaukee & St. Paul table have in addition to the bronze washer at the outer edge of the conical rollers a ball-bearing ring at the center and the two are tied together, keeping the conical rollers where they belong, which appears to be a very good detail. However, I want to say again that what seems to me to be the secret of turntables operating nicely, is to keep the centers and everything about them clean and to use a good quality of oil in the center. Then when it gets down to 10 or 20 degrees below zero, one won't have as much trouble as if he had not kept the table clean.

Mr. Reid:—We have a drawbridge 123 ft. long, over the Grand river, which was used for a time on the main line, and later,—after

the main line was double tracked,—it was taken down and erected at Grand Rapids. This has a disc bearing which carries the entire draw span, the pony wheels being designed only to prevent tipping. Both ends are raised with a mechanical lifting apparatus before turning. Two men turn that bridge under any conditions, and many a time one man will turn it. We have had no trouble when it is kept properly oiled. The river is frozen in winter and the bridge is not opened. In the spring the river frequently gets up so that it deposits mud and rubbish over the pier and has been up as high as the ties on the bridge. At such times a great deal of sediment is deposited all over the bridge and we have to clean it thoroughly. We have never attempted to put water-tight planking over the centers of our tables, on account of the frequent derailment of engines. The enginemen or roundhouse men operating the tables are not as careful as they might be in lining up the rails and in locking the tables in position for the engines going on and off, and frequently they run almost entirely across the table on the ties. Of course, that would ruin any water-tight floor. It is bad enough on the ties, but they can be replaced with comparatively little trouble, and a water-tight floor is expensive to replace every little while. We have water-tight floors over the drums and centers on our drawbridges to keep out cinders and other refuse that drops from passing trains. They are a help, but do not keep out all of the dirt, because cinders will get in anyway.

Another trouble that we have had, and probably one of the principal troubles we have with our turntables, is a lack of attention on the part of the men in charge. They prefer to do anything, apparently, except take care of them. They don't oil them, especially where they have power tables. I have seen pony wheel journals taken out where the journals have worn two inches into the cast iron bearings of the table, and I have seen pony wheel journals worn entirely off. Another trouble arises on account of the difference in elevation of the rail on the table and the rail on the approach when an engine is coming on or going off This always causes more or less pounding and the rivets or bolts in the floor-beams supporting our end trucks have worked loose in a few cases causing us some trouble. Another difficulty is the cutting of the circle ties on the parapets. I should think that in some of the cases mentioned in the report here, the bedding of I-beams or rails in a concrete parapet would be even worse than the use of oak ties. When an engine drops off a table or climbs up off the table

on to a rail bedded on a steel I-beam or any other rigid material in a concrete base, it is only a question of a short time until the concrete will wear or the steel will loosen up and begin to churn. I should think an 8 in. parapet timber or oak tie would be far better. We use those on the Lake Shore. In regard to the circle rails,—the best of our tables have creosoted ties buried in the concrete and the circle rail is carried on them. In those cases we have had very little trouble.

One question raised was that of lubrication and the squeezing out of the oil on account of excessive loads. On some of our turntables and on all of our drawbridges, we use graphite grease for heavy lubrication and it is the best thing I have been able to find. We have never found a case yet where graphite grease would not work effectively, no matter how heavily loaded. If the grease squeezed out, the graphite remained, and that in itself is a very good lubricant.

Another trouble with the table has been the excessive deflection. One result of excessive deflection is the necessity for setting a table high on a center in order to clear the end rail when loaded. I have seen tables that would sit with one end bearing on the circle rail and the other end would be 3 in. above the rail, but when loaded both ends would be down on the rail. If an engine comes on the table, with any speed at all, it makes a tremendous pounding, throwing the receiving end of the table down 1½ in. That brings us back to the necessity of designing a table that is rigid enough to eliminate excessive deflection. The suggestion of designing a table to give ¾ in. clearance when light and ¼ in. when heavy, is a good one. It looks doubtful to me, though, whether we could get an 85 or 90 ft. table which would not have over ½ in. deflection under the maximum load. I don't say it can not be done, but it would require a heavy table to do that. With the constantly increasing load and the naturally increasing length of the table, in my own opinion, it is only a matter of time when we will have to come to a through girder table in order to get the proper depth of girder without an excessive depth of the pit.

Mr. Smith:—I am surprised that bridge engineers and other officials of railroads who have to do with the designing of turntables, have let themselves go so far wrong as to design them too light. The railroads write specifications for bridges, but the great majority of the roads, probably 95 per cent of them, are still buying turntables handed to them by the manufacturers. Those turn-

tables are bought on a competitive basis. I got my knuckles cracked two or three years ago, when I turned down a standard design of a turntable that had been adopted by a great many roads, and that was made by a firm that manufactured and sold hundreds of turntables, and adopted in its place a design which showed a much heavier table and which cost more money. The management bought two of the heavier tables, but a week later we got a letter saying that twenty of the ligher tables had been bought. The chief engineers and bridge engineers are considerably to blame, but they have to maintain the tables after they get them. Now, this report says, "Although a bridge designed for Cooper's E-50 or other Cooper's loading will support, without any increase in stress over that used in the design, actual modern engines considerably heavier than the Cooper's loading, (on account of the longer wheelbase of the modern engines distributing the load over a greater length of bridge) the same engine on a turntable will cause the stresses that affect the deflection of the ends to very materially exceed those used in this design for the reason that the longer wheelbase increases the negative bending moment on a turntable. This is well illustrated in the diagram comparing the effect and appearance of Cooper's E-50 loading to modern heavy Mikado, Pacific and Mallet type engines which cause stresses in bridges approximately equal to those caused by Cooper's E-50. On a turntable the negative bending moment at the center corresponds to that caused by Cooper's E-100 for the Mikado, E-110 for the Pacific and E-170 for the Mallet. If the turntable were designed for any such unreasonable values of Cooper's loadings the tresses in other parts would be increased out of all proportion to the requirements. The reason why Cooper's loadings cannot be used in turntable design is readily apparent from the above. It appears that the tables should be designed for the heaviest actual engine in service anywhere that could use them." On that basis, the Missouri Pacific is still designing their bridges for Cooper's E-50 loading, and will probably continue to do so, but it works exactly opposite in the case of a turntable. The figures shown in diagram, on page 154, account for the excessive deflection that Mr. Reid tells about. He wouldn't have a bridge in his territory that gave a 3 in. deflection; but compares the Cooper E-50 loading at the bottom of the page with the Mallet compound at the top. All bridges designed for the Cooper E-50 loading at the bottom of the page can be used for the Mallet compound, but I wouldn't let that Mallet compound on a turntable I had built

for a Cooper E-50 loading, for the reason that the moment at the center on the Cooper E-50 is 2,149,260 ft. lbs. and on the Mallet compound it is 7,228,000 ft. lbs., about 3½ times as great. Now, the engineers who have had the designing of turntables to do, are responsible for that condition. They give you a "paper" turntable and it don't stand up. Turntables should be designed so that they will stand up, and if that fact can be hammered home, we have accomplished something. In regard to the tipping of drawbridges on disc centers; the last three years I put in four drawbridges that were 270 ft. long, single track, but very stiff riveted, each of the four. My own experience on two other roads had led me to believe that disc centers for drawbridges were best. The American Society of Civil Engineers went into the subject a few years ago and recommended the use of disc centers under drawbridges. One of these four drawbridges was a single track 150-ft. deck plate girder draw, that can be turned by one man. I have run around with the lever and left the table spinning. The leverage there, of course, has to be multiplied by gears. Two other drawbridges were 270 ft. long, single track, but very stiff riveted structures, turned by one man. The drawbridge referred to in the table is a 260-ft. double track draw and very stiff. The eight wheels are for balancing purposes only. Before the draw was accepted, it was so adjusted by a machinist of the bridge company, that when the draw was turned by the gasoline engine, not one of the eight wheels turned. They were adjusted to a little less than 1-16 in. above the track. We swung the bridge about a dozen complete circles and kept it spinning and not one of those wheels touched the track at any time. They will touch occasionally, but the load on the wheels will be inappreciable as compared with the load on the center.

Mr. Alexander:—We had quite a number of Fritchie turntables on our road originally with two steel discs, 6 in. in diameter working together. They were very satisfactory tables when properly adjusted, and turned easily, but we found that in our climate the frost and ice affected us so much in the winter time that we had to allow more tip to the table than was proper, on account of the ice raising the circle track. When the table was in that condition, if an engine happened to be one-sided, because of a large air-pump, or of the coal being loaded wrong the table would tip to one side. These tables had an extra bracing of angle irons riveted in place but they could not prevent the table from tipping

some, and if two or three wheels on one side touched the rail, the table was very hard to turn. We overcame this by putting in a roller center.

Later we got several 60-ft. Edgemoor tables and found no tröuble with them. Two men could easily turn the largest engine we had on them. The end wheels were a little larger on the Edgemoor than on the Fritchie table and very loose in the boxes so that they would adjust themselves. These Edgemoor centers consisted of rollers three in. long and three in. in diameter at the large end. We thought of putting that kind of a center in the Fritchie table to overcome our difficulty and did so with good results. Afterwards, we wanted a larger table and we got four deck plate girder tables with conical roller centers from the Pennsylvania Steel Co. This type of table had hardened rollers nine in. long and five in. in diameter at the large end. These rollers were not properly adjusted and the tables turned very hard. I was sent to investigate the trouble and I found that the pitch of the rollers was not just right, although only a very little off, creating too much friction. We wrote to the Pennsylvania Steel Co. about this and they sent us new centers, similar to that of the 325-ton Philadelphia turntable shown in the report with inside and outside circular bands or rings with pinions in each end of the rollers, which preserve the spacing of the rollers and prevent their rubbing together. We have had no trouble with that center, but the four end wheels in that table are smaller and are too tight. If they strike on the end the table is almost hung up but there is a friction control on the center so that one can balance the engine and prevent either side of the table from striking. We have very little trouble with the end wheels, although if they do strike they are too tight.

Our engineers thought the girders of the Fritchie tables were a little too weak and we put a core plate on the bottom and top of one of them when we changed it. We had a great deal of trouble with the last one which we only changed last summer and the trainmen complimented me a few days ago on the good job we did as we have never had any trouble since we changed the center. The circle was all right, but the table would wind and the wheels would strike on both ends of the table. Also the first Fritchie table we got had adjustable bracing and when it got in wind a little, we could adjust it with the rods. They never sent us another like that but sent the other with angle irons riveted in. When they got in wind, we had to adjust them by the corner. The Edgemoor

table has a cross-bracing, which is adjustable, that is, a turnbuckle is provided on some of them.

Mr. Clark:—There is another phase of the turntable discussion that has not been touched on yet, and that is the power for turning the tables at small stations. We have been told by some that they turned the tables by gasoline engines and some by electricity, but at stations where one cannot well install such power we have been using the air motor tractor to some extent, with very good results. We take the air from the engine that is being turned.

Mr. Pickering:—Do you have any trouble with air motors freezing up?

Mr. Clark:—No sir, I never had any freeze up.

Mr. Smith (reading from committee report): "Expressions from a few roads are as follows:"

A. T. & S. F.;—Air motors will work satisfactorily if proper care is exercised in the arrangement of the drainage to prevent freezing. The motor is not fool-proof, but it has given extremely good service on our lines.

B. & L. E.;—We would use no other power than electricity unless current could not be obtained.

B. & M.;—We have installed many gasoline motors, but are changing to electric motors wherever current can be obtained.

C. R. R. of N. J.;—We use air supplied from locomotives.

C. & N. W.;—Electricity has proved very satisfactory and has been installed at all points where we generate our own power.

C. R. I. & P.;—We use air motors. We do not find these very satisfactory on account of the motors freezing up on our northern territory. In the future we will probably use electricity where current is easily obtained.

C. C. C. & St. L.;—We find air motors unsatisfactory on account of freezing in cold weather and more expensive to maintain than electric.

E. J. & E.;—We recommend overhead collector rings as we have had trouble from wires placed underground on account of dampness causing short circuits and ice in the pit affecting low collector rings.

Great Northern;—Gasoline is used only where air and electricity are not available. The objection to gasoline is the increased fire risk.

I. C.;—Air gives trouble in cold weather unless air pipes are placed underground.

If Mr. Clark will read the last six or eight pages of the report he will find what 57 roads say about turning their engines.

Mr. Jutton:—I think it is very important to have a good foundation for the circle rail and to have the rail in good surface, because it stands to reason that if the circle rail is high in some places and the load on the table is such that the clearance between the end wheels and the circle rail is very small, when one comes to a high spot, he has to raise the engine over it. I have heard of cases where they balanced the engine several times to get it over these high spots caused by heaving from frost. If one has a shallow foundation that the frost can get at he is liable to have a bad surface on the circle rail in the winter time.

Mr. Alexander:—I would say that we have concrete foundations that do not heave, but we have rain storms in the winter which cause trouble. We lay short ties on concrete under the circle rail. They are fastened to keep them from shifting the circle but not to anchor them down. The rain falling on the concrete will work under the tie and lift it. We can't avoid that, but the concrete itself does not move.

Mr. Jutton:—It is also very important to keep the ties in good condition. If a few get soft, one has low spots, and there is apt to be a low spot where the engines go on and off the table.

Mr. Alexander:—We put stronger ties in such locations to guard against that.

Mr. A. S. Markley:—We put concrete under the ties and also between the ties up to the top on the inside of the circle, sloping it towards the center, on the in-going and out-going tracks. Where we go into the roundhouse we lay three rails and anchor them directly to the concrete, which overcomes all of that difficulty. We have had one table put in in this manner, in Chicago, for four years, and have had no trouble from this. On the ties, however, we have ¾ in. plates the full width of the tie to prevent the rails from cutting into them.

With reference to the center, an improvement can be made on the present cone-shaped center that I believe would prevent the dirt and dust getting into the oil. Dust and dirt getting into the oil in the center is the cause of one of our greatest troubles. If a flange was brought up to the top of the rail on the lower bed, above the top of the rollers, clearing the upper casting about one

inch and the space filled with oil, it would prevent any dirt from getting into the center and would not cost very much.

One of the gentlemen spoke about a roller bearing on the end of the rollers. We have two tables of that class, built by the King Bridge Co., one of them with the end friction roller on the end and the other without. We installed them the same year and never could see very much difference in the operating of the tables. The one without the roller bearings operated about as well as the other one with them. The rollers get displaced and they have to be renewed, costing about $40. We also have a table where the rollers are all kept separate but one would scarcely see any difference in the turning from the other tables that are not keyed.

We have trouble on account of over-load. If an engine breaks the roller cage it is out of service for about five days before we can get a new cage made. We recently installed a new center in a table in Brazil, Ind., with a steel roller bed on top and bottom. We have not had sufficient experience with it to know whether it will work out or not. One has to take out the other rollers every six months or a year, clean them and in many cases chip off the top or lower castings on account of the rollers wearing into the bed so that the castings bind on each other.

Mr. Penwell:—I am glad that Mr. Markley brought up the point of the end bearing on the cone-shaped rollers. That has been a source of annoyance with us. We use the type of table that he speaks of and as the little balls designed to take up the friction on the end of the controller and the plates become worn a little, the balls will get through on to the rollers, cut ridges in the track and ruin the whole center. When we first put in a center of this kind, not anticipating any trouble, we paid very little attention to it; but the first time we cleaned it, we found 15 or 20 of those little rollers ground into the bed. We finally became disgusted with the little balls and took them all out and I could see no difference in turning the table. That center was so damaged by those little balls, that we finally had to change it out.

Mr. A. S. Markley:—Didn't you have to substitute a plate on the end of the rollers for the friction rollers?

Mr. Penwell:—We used the same plate that was on them. We simply took these little balls out and operated the table without them. The plates on the end would turn and take up the friction to a certain extent. I talked with the master mechanic

who operated that table and he said he could see no difference in the turning of it; and they were turning it by hand at that time.

We have been bedding our circle rail on the concrete wall, but this is not entirely satisfactory, as it cuts into the concrete where the engines go on and off the table. Also the ice falls under it in the winter and causes a bad surface in the circle rail. I am inclined to think that the plan of having the ties bedded in the concrete would be a good thing if we could use creosoted ties and proper tie plates.

Mr. Pickering:—There is a point that I would like to make in regard to the ice forming back of the circle rail where it was laid directly on the concrete. We had a lot of difficulty along that line. Up in our country we get a snow storm, followed probably by rain. The man who takes care of the turntable will not get the snow out from back of the circle rail, the rain comes and by and by there is a great mass of ice there which tends to force the circle rail out of position and some of it gets on the circle rail, making the table turn hard. We have recently adopted the practice of bolting a short tie on the top of our concrete and placing our rail on that. It is giving us very much better satisfaction, as it gives abundant room between the ties for the ice and snow to work out.

Mr. A. S. Markley:—Don't the ice and snow get under the ties the same as it does under the rail?

Mr. Pickering:—No sir, we have our ties bolted down and have no difficulty with the ice and snow getting under them.

Mr. Swartz:—At our main line terminals the engines handled are the Pacific type. We came to the conical bearing after several years of experience, but had difficulty with that and have now reverted to the ball bearing, similar to that shown in the report. We find that about every 18 months or two years, we have to fix those centers. Either the balls crack and give out, or the frame that holds the balls in position will wear and I have known of instances where the studs have been weighted so heavily that they broke off and allowed the frame to come off and the balls to climb on the frame. We find that the ball bearing center is the most satisfactory. We use air to turn our engines and sometimes 15 lbs. of air will do the work. As to the difficulty of keeping the ice away from the circle rail—we have had that to contend with and we now use the concrete foundation with a wooden tie, running a steam pipe around between the wall and the rail. We have found this a very

good thing as it keeps the ice from settling there. The water all runs to the center and as we have a steam pipe encircling the concrete frame, the water drains away quite readily. Our only difficulty now is to get some center that will stand for a reasonable length of time, as the conical bearings and the discs have never proved satisfactory with us. We have found the ball bearings are perfect, except for durability.

Mr. A. H. King:—My experience has been that if a turntable could be devised without any wheels or circle rail but simply with a bearing that would afford a support when the engine strikes the table so that it is a perfect surface with the rail on the coping, it would be a perfect working table. If the table was out of order so that it becomes necessary to turn it by hand the wheels at the end of the table would be an advantage. I fail to see where a table can be improved in its working by depending in any measure on the circle rail or the wheels on the circle rails, and whenever it has been necessary to depend on those, I have found that the table was out of order so we generally jacked it up and found out what was the matter with the center.

Mr. Edwards:—We were using turntables without any wheels at one time, using simply the bearing plates at each end of the table. We had at that time and still have on our centers a rocker bearing on the saddle casting, and the saddle casting is on conical rollers. This roller bearing gave a space of about 18 inches between the rockers in which the table balanced. We thought that would give sufficient margin to allow the hostler to keep the ends clear of the circle rail in locating the engine on the table, but there was always more or less trouble with that, simply because they would not take the pains to balance the table closely. With heavier engines we have added an end carriage at the free end of the table, that is, the end opposite that to which the motor or electric drive is attached. As far as I know, we are the only road that at any time ever used simply a bearing plate and discarded the end trucks entirely.

Mr. Sheldon:—I think our principal trouble is from the center, arising largly from the neglect of the designer. He has not kept the design of the centers up to the growth of motive power. The rollers and the disc are too small. I have in mind a conical roller center that was built and put into operation, as near as we can learn, about 1870. There were eight rollers built in a carriage, with trunions or axles on each end of the rollers and the carriage

slipped down over this which kept the center line of the rollers in radial lines with the center of the table. That center is turning Atlantic and Pacific type engines today and has been turning engines there ever since that time. The greater part of its life has been where the service was rather light, although at times we have moved it from one place to another. It is now working under a 66 ft. turntable where I think it turns approximately 75 to 100 engines a day, some of them of the larger type. I ascribe the success of that center to the rollers, which are 5½ in. in diameter, but I think they are none too big. The man who designed it was 40 years ahead of his time, because I don't think anybody designs over 5 in. rollers at the present time. I will say that the rollers have worn out one cast iron cage or frame that they run in and we had to substitute steel. This has given us no trouble, which I ascribe to the heavy, strong construction. If we will catch up with our centers, whether discs or rollers, we will have much less trouble. I think that a drawing of that table was submitted to the association 12 or 14 years ago and the same old center is still doing business.

Mr. A. S. Markley:—I did not suppose that anybody had a table without end rollers. We happened to have one that had cages for the rollers. Our trouble began as soon as we put it in and kept up until we got it out. We had to put on end rollers.

Mr. Smith:—In a good many cases we have not had any circle rail at all except under the free end of the table, but where there has been a circle rail or any blocking for that shoe to slide on, there has been trouble just as soon as the shoe came down, because it created the friction which was multiplied by an arm equal to half the length of the table. In some cases it has been impossible to turn engines at all. I asked a conductor one time how many men it took to turn the table and he said that it depended on how many men happened to be in town when the engine arrived.

Mr. A. S. Markley:—I presume that table had a larger center, did it not?

Mr. Smith:—15 ft. radius.

Mr. Penwell:—We have had an old turntable such as Mr. Sheldon described, part wood and part iron, built in 1870. Its center was the same as he described, and we are turning engines on it yet. The wood has been renewed a number of times. The table has been considered ready for the scrap pile ever since I have

known it, and we have not spent a cent on it for a year. Of course it is turning light engines on a branch road, but I am inclined to think, with Mr Sheldon, that the rollers today are entirely too small. The outer ends of the eight rollers under the table I speak of are eight in. in diameter. I have never seen a time when it required over two men to turn the ordinary light engines such as we use on branch roads, and if the table is properly adjusted with the old fashioned hog blocks that are still on it, one man can easily turn an engine. It gives us less trouble than any table we have.

We have a number of tables that have been overloaded. We have three or four tables that require two and one-half to three inches tip to take up the deflection in the table under the engines they are turning—that is, an inch and a half on each end. When those tables get in wind they buckle in the plates in the center of the panels and the stiffeners are slightly sprung. It seems impossible to take the wind out, and while we will all agree that the proper thing to do is to take the table out and put in a heavier one, there are so many of them that one cannot get the appropriations to do what he would like to do. One-half of our turntables should be scrapped and the other half, now under heavy engines, put under light engines. When one turns any heavy engine on a table that has a wheel base within eight inches of the length of the table, he cannot balance the engine without first filling the tank with water and coal which adds weight, and even then it takes several men to turn the engine. The result is that one grinds the center out and secures unsatisfactory results. Our plan now is to change our standard from 80-ft. to 85-ft. and then move the heavier tables on to the branch roads to take care of the light engines and scrap as many as we can get the appropriations to renew.

Mr. Smith:—I want to say a word or two in defence of the engineers who have designed these poor centers. They have been between the devil and the deep sea, like the manufacturers of motor cars. There has been keen rivalry, and as a result, just as little money has been put in as it was possible to make cars for. In recent years some of the railroads have gone to designing their own centers, and I cannot show the comparison between the tables designed by the chief engineers of a railroad and those offered by manufacturers better than by referring to this report. The drawing of the standard turntable of the Chicago, Milwaukee and St. Paul provides for rollers 8½x4 in., a considerable increase in size, both

in the diameter and length of the roller. Many of the roads reported the same trouble as the members here have been reporting today with reference to small rollers, and you will find the following in the report below the drawing just referred to:

"The conical roller centers appear to be satisfactory if properly designed, constructed and maintained. Improper attention to these features has caused much trouble and much criticism of this type of center. One of the principal faults with the design of former conical roller centers, was the small length of the rollers which created unit pressures greater than they should have been. This resulted in the wearing and flattening of the rollers and in the wearing of the rollers into the surfaces of the top and bottom castings. The conditions could be improved by planing the castings, but the trouble usually resulted in the renewal of the rollers and of the castings, practically the entire center, which was expensive. In later designs the length of the rollers was increased and track plates were attached to the top and bottom castings, so that in case of wear the track plates and not the entire castings are renewed. The rollers and track plates should be of hardened steel and the castings of steel.

"In the early designs of conical roller centers no means was provided for keeping the rollers a constant distance from the center although there is a tendency for them to crowd out or to work in on radial lines. Their working in, which seldom took place, resulted in their rubbing on one another with consequent increase in difficulty of turning. Their crowding out resulted in the top and bottom castings coming together and rubbing and in the outer ends of the rollers working against the rough inner surface of the castings with the consequent damage to rollers and castings and increase in difficulty of turning.

"In later designs and more particularly for the heavier tables, means is provided for holding the rollers in line. Some makers do this by placing the rollers in a depression of the bottom casting, the casting being raised at the outer ends of the rollers to make contact with their ends and rubbing takes place here during turning. If the rollers are of steel and the casting also of steel as should be the case, cutting may result if there is any tendency for the rollers to crowd out. The most approved practice consists in the placing of a steel ring, called a live ring, around the rollers, set screws or lugs projecting from the end of each roller or bolts passing entirely through the length of the rollers and through the

live ring; this ring answers the double purpose of keeping the rollers from crowding out and keeps them the proper distance apart. In some designs, especially where bolts pass through the rollers, rings are provided in a similar manner for the inner ends of the rollers, which with the bolts, form a spider."

The point I want to bring out is that the St. Paul center cost approximately $1,000, but it is a center which is considered necessary for a 335 ton turntable by the St. Paul railway. If the railroads are willing to pay $1,000 for such a center or a corresponding amount for a less capacity they will get a good center, but by the time a conical center is designed and built strong enough so there will be no trouble one will have a large number of parts.

"If the rollers work in or out against the live rings the rubbing causes friction that cuts into the metal and increases the difficulty of turning. To overcome this, phosphor bronze frictionless washers or ball bearings are provided in many designs between the ends of the rollers and the live ring."

But it is possible that a center can be designed in which there will be fewer parts and that will cost less to make.

Mr. A. S. Markley:—Is there not danger of getting the rollers too large?

Mr. Smith:—Yes, there is that danger, but it is difficult to say what the roller limit is. The trouble is that they generally get too small. There is very little danger of their being too big.

Mr. Penwell:—I fully realize that we expect things of the engineer that are almost impossible for him to carry out. The principal reason, that of the expense of the center, has already been assigned. If we can get our managements to understand the importance of the center it is money well spent, for there is not only the first cost but also the constant maintenance of a poor center. I think that paving the bottom of the turntable pit will pay. That also is difficult to prove because it may be difficult to show the amount of money saved. I believe it would pay to pave all the pits; in fact I have recommended it to our people to pave pits for turntables that are permanent. I think we should pave the bottom of the pit with brick or concrete and thereby protect the table and at the same time make it much more convenient to clean out the pit. If the shop men have a smooth surface to work over they are more apt to keep the pit cleaned out than if they have rough cobble stones or cinders to work over.

Subject No. 11.

PAINTING OF STRUCTURAL IRON AND STEEL FOR BOTH BRIDGES AND BUILDINGS.

REPORT OF COMMITTEE.

As a number of separate and distinct operations are necessary in the proper performance of a job of structural steel painting it appears best that the subject be divided and the different stages separately presented. Also in this discussion, the process of coating new steel, and the work of repainting old structures should not be confused.

Scientific research and numerous practical tests have demonstrated the fact that certain paint pigments, though possessing excellent moisture repelling properties, will actually stimulate corrosion when applied directly to steel surfaces, while certain other pigments have a tendency to restrict and repress corrosion when used for primers and foundation coats. Because of this we divide the pigments into rust retarding, and air and moisture excluding ones, using the first for priming and contact coats, and the latter, for finishing and exposed outer surface purposes. The pigments used in steel protective paints of the first kind are principally, red lead, oxides and the like, while carbons, lamp blacks, graphite, etc., belong in the other class.

Shop Coating.

A rust retarding coat may be suitably compounded from red lead mixed with pure linseed oil. The average stock mixture may consist of from 25 to 30 lbs. of red lead to the gallon of oil. This mixture can then be reduced to the proper consistency at the time of application. A small amount of turpentine added to this brush coating, will greatly help in its manipulation and will also provide for proper penetration. Red lead should always be mixed at the time of its application for it settles quite readily, as it is an extremely heavy pigment. If so desired, the settling can be retarded, to a certain degree, by the addition of a small amount of asbestine (magnesium silicate) in the proportion of about 20 lbs. of red lead and 2½ to 3 lbs. of asbestine pulp to the gallon of linseed oil. A small amount of turpentine should also be added to this mixture for the purpose mentioned above. A good workman is required to properly apply red lead paint because of its more or less difficult application.

Natural oxides have also proven to be very good for priming purposes, and very satisfactory results are recorded from their use. A number of consumers favor oxides because of their easier application and the less expert class of labor which is required to apply them. A saving of from five to ten per cent, as compared with red lead paint, can thus be effected. Some concerns are using a combination of red lead and oxide and make good reports regarding it. A number of reliable paint firms have similarly composed products on the market, which are sold under certain trade names, and some concerns have adopted them as their standards.

Although quite extensively used in former years, linseed oil is rapidly losing favor. It appears to be a universal opinion that linseed oil is not a desirable material for the prime coating of metals when used without the ad-

dition of pigments. A foundation coat of linseed oil is very often the direct cause of peeling and blistering of the other several coatings applied over it. The oil is seldom dried enough to insure close adherence to the metal surface which it covers before the other paints are spread over it. When the subsequent coats of paint are spread, the solvents and oils in them are bound to soften to some extent the underlying coat of oil, and the moderate heat of the sun alone is sufficient to cause the whole film to draw up, blister, and finally peel. Too much oil in a paint coating, particularly when the surplus is in or near the foundation coat, will generally cause blistering and peeling, regardless of the pigments used in the coatings. If on the other hand, the erection or final completion of an oil coated structure, should for some reason become delayed, this oil film which deteriorates much faster than a paint coating, will have practically perished, its surface will be morbid and dead and will not have strength and stability enough to carry any subsequent coats, which when applied over this kind of a surface, will also peel.

Field Coatings.

Paints containing the same kinds of pigments as for shop coatings, can be successfully used for the first field coat, providing it is covered with another elastic outer coating. If that is not done, paints suitable for finishing coats should be applied, and the first field coat omitted. Red lead or oxide priming should be darkened for this coat by adding carbon or lamp black in the proportion of 90 to 95 per cent of the reds and 5 to 10 per cent of carbon mixed. The addition of this black will not only help to make the coating more elastic, but will act as a guide to determine if the former surface is being completely covered because of its darker shade and the shade is also brought nearer to the color of the black finish coating.

Carbon, lamp black, and graphite pigments, singly or mixtures of them, have given best satisfaction as outer surface and finishing paints. These, combined with some inert and reinforcing pigments according to special formulas form the basis for nearly every brand of paint for the satisfactory metal coatings on the market. The addition of some high grade gum like "Kauri" improves a finishing paint greatly, producing more elasticity, resistance and life. It is of course just as essential, that the oils entering into the makeup and composition of the various paints are of the proper kind and quality, as that the selection and composition of pigments be properly made and storekeepers or other officers charged with the duties of passing on the merits of goods purchased, should be very alert and strict in regard to linseed oil. Paints containing tar or those with a tar base, should not be used on steel structures exposed to the sun and weather, as tar paint films rapidly check, crack and "alligator."

Repainting.

When for any reason it becomes necessary to repaint an iron or steel structure, the paint should never be applied in wet or freezing weather, and the surface should be freed absolutely from all scale, rust, dirt, etc. It is not sufficient to merely apply a fresh coat of paint over an old paint surface under which traces of paint corrosion appear, for while the new paint will cover up the old surface, and may adhere firmly to it, corrosion goes on beneath the paint just the same. Freeing from rust and corrosion and perfect cleaning are positively necessary. When for some reason, it is not possible that the entire structure can receive a coat of some rust retarding primer. the parts cleaned and freed from rust, and all the exposed surfaces, at least, should be touched up with either a red lead or oxide primer, before the finishing coat is given. The use of turpentine, in the paint applied over the old surface, is advised, as turpentine is a penetrant, providing the penetration and adhesion between the old paint film and the new coat.

Although more expensive cleaning by sand blast is much more thorough than the hammer, chisel, scraper and wire brush method, and the greater cost is readily offset by better results in the end. The sand blast

method thus far has not been very extensively used, so the committee has not been able to gather full data as to the cost, etc., but we believe that the matter is worthy of deliberate consideration. Where the steel has been cleaned with the sand blast, and promptly painted, it has not shown signs of corrosion again nearly as quickly as steel cleaned by hand.

Occasionally we notice defects showing up here and there on a steel structure within an unusually short time after the completion of the painting. On looking into the matter we find that nothing extraordinary has occurred during the progress of the work. Everything has been handled in the usual way, the general course of mechanical procedure has been followed, and still improper results are appearing. We recall no acts of our own to which to lay the blame and are finally compelled to look for the cause previous to our own handling of the work, or to the priming which was done at the works or in the mill. We are not certain beyond a doubt, so we decide to visit a mill, and there make personal observations which may very probably result as follows: In one part of this enormous plant we find the inspector busy in the pursuit of his duties checking, comparing specifications, testing, weighing, and attending to the many details connected with his work. In the meantime we notice in another remote part of the place a bunch of unskilled laborers mopping paint onto some steel that had been sent along for priming, using large 6 in. or 8 in. flat brushes, and covering over mill scale, rust, dirt and other imperfections, each and every one a destructive agent and an enemy to the life of steel. We observe all these stimulators of corrosion brushed over and covered up with paint, but not removed, and so the march of the corroding process is sure to go on. We next pay attention to the paint they are using and learn that the package which was opened some time ago to be inspected, and was left standing uncovered all this time, had contained the standard paint as specified, but now through neglect to properly cover, is no longer fit for the purpose used. On examining the contents of the package closely, we also notice that the paint is scarcely stirred up, and we see that the oily substance from the top of the mixture is first used, and as the work progresses and the material is consumed, the paint becomes heavier and intermixed with more or less pigment, until when the lower part of the package is reached nothing is left but a semi-dry pigment, which will no longer spread under the brush. Now, to assist in brushing, the men reach for the benzine can, and reduce the paint with it, destroying what little life the paint had first contained. In this way, a number of different surfaces and films are created, on the same structure, and from the same package of the so called protective coating.

We proceed further, and find at other parts of the mill, though this time under a covered shed, more laborers applying a shop coat to other sections and parts of the structural steel. Here we notice exhaust pipes of all kinds steadily discharging vapor and moisture which finally settles and deposits on the steel. Under such conditions the steel cannot be perfectly dry, however much it may appear so, yet the painting is done just the same, these layers of moisture are enclosed between the surface and the steel, and the paint which is supposed to close the pores, and firmly adhere to the steel, is merely attached in some places and spots, and a weak foundation is created, which is absolutely unfit to receive and successfully hold subsequent coats of paint.

While we have gathered all this valuable information, the inspector has found an opportunity to inspect the painting on these various sections of the steel. He looks at the job, and as it looks uniform in color, he regards it as properly done, because it is outwardly covered over with paint. The material is consequently passed, loaded and shipped.

The foregoing illustration may appear somewhat severely drawn, and the situation presented, greatly exaggerated, nevertheless, if a number of troublesome cases were thoroughly sifted, the illustration, in part, or in whole, would be identical with the underlying cause of the trouble.

It must not be construed that our illustration is intended to cast any reflections upon the inspector or his methods. On the contrary, it is sought

to imply that he uses his principal efforts in a direction considered primarily important, which is, the correct fabrication of the parts composing the structure. No matter how diligent and untiring an inspector may be, it is not possible for him to be in a number of places at the same time, for, in large plants, where modern methods are pursued in the manufacture and assembling of steel, the various departments are sometimes miles apart.

Of course, not all failures are due to work which was first painted at plants, for often even among so called intelligent mechanics, the belief still exists that anything in the way of paint is good enough for priming purposes, so long as it is going to be covered again with paint, thus entirely ignoring the fundamental principles of a correct foundation.

It may, therefore, be suggested that considerable attention be given to the education of men who deal in, or supervise the erection and maintenance of steel structures, so that greater interest in the problem will be aroused, better coöperation between the various departments effected, and the proper men chosen to handle the different lines of work.

CHAS. ETTINGER,
R. H. REID,
E. E. WILSON,
O. F. BARNES,
O. F. DALSTROM,
Committee.

DISCUSSION.

Mr. C. Ettinger:—The committee was unable to cover the subject as fully in this report as some of the other subjects have been, as the progress in the outlined does not seem to have reached the stage where we can report entire satisfaction. The greater part of the report is necessarily devoted, therefore, to a consideration of evils.

Mr. Killam:—I would like to ask the chairman what virtue there is in lampblack mixed with paint, beyond giving a coloring or tint?

Mr. Ettinger:—If one takes a pound of lampblack and a pound of any other pigment, such as red lead or other oxide and grinds them in oil, he will find that he can squeeze 35 per cent more oil into the pound of lampblack than he can in the oxides or any other pigment of that kind. It is universally conceded that the oils, combined of course, with pigments, are the things which preserve our structures. The elasticity in the oil is the property that does the work. You have undoubtedly observed station signs coated with lead on which the name appears in black letters, where the letters which were repeatedly coated with black on top of the white lead are actually embossed and are standing out. Time and again the elements have worn away the white lead, but the black has remained and built up this higher

surface, proving beyond a doubt that black of that kind or the pigments which take up the most oil are the pigments to use for outer coatings, because they contain more elasticity. With steel moving backward and forward, the expansion and shrinkage will surely be taken care of better by an elastic surface, than by a surface that sticks closely to it and is bound to crack and check.

Mr. Killam:—Our line runs through a country of varied temperatures and I have found that the temperature of a country has very much to do with the elasticity and lasting qualities of the paint. We have, for instance, a draw bridge across the Strait of Canso, certain portions of which are dipped once or twice a day into the salt water. Different kinds of paints have been tried here, some lasting a year or two and others a very short time. The chief engineer got up a preparation of red paint and lampblack and ordered that put on the draw. We had a contractor do the work and I got him to paint one side of the beams that dip into the water with this formula of red paint and lampblack, and the other side with Walter Carson's Anti-Corrosion Paint, manufactured in London, England, and used on the warships. The next year, the side that was painted with lampblack and red lead was practically exposed while the other side painted with Carson's lasted two years. On some of our bridges, such as the one across the Grand Narrows, the salt air and the fogs come up along the bottom chords of the bridge and take the paint off in two or three years. This is one of the places where we test paints, by painting pieces of steel and hanging them over the side of the bridge. I examined some 37 pieces last year, only about four of which were in such condition that I could tell what kind of paint was on them; the others were all rusted and gone. Take the same kind of paint and use it inland as in Quebec, where the climate is dry, and it will show that the climatic conditions existing where these structures are built, has as much to do with the life of the paint as the quality of the paint itself.

Also there is no question but that the cleaning of the steel before it is painted materially affects the life of the paint. We have had work done by contract and I have found pieces blistering up as big as one's hand within three weeks, in which cases I have refused to pay any money until the contractor cleaned the bridge, scraped the paint off and gave it three coats of paint where he needed only to give it two in the first place. I have

known of bridges similarly situated, which had been neglected until the steel along the side where the water floor was, was pitted so that a sand blast would not touch it and nothing would clean it but a hammer and cold chisel. It is one of the most particular and one of the most difficult things to get bridges, particularly along salt water, painted so that the paint will stand the test.

Mr. Ettinger:—How great a pressure did you have when you tried to clean off that scale with the sand blast?

Mr. Killam:—I do not know the pressure exactly, but it was a machine made by Fairbanks, Morse & Co., and guaranteed by them. Ordinarily, it did its work, but there were places where it would not, because the scale on that iron was harder than the iron itself.

Mr. Ettinger:—Those scales are usually loose.

Mr. Killam:—But when one gets them off, there is a hole in the steel where they come off.

Mr. Ettinger:—About three years ago I painted a structure, under the worst conditions one could imagine. The bridge had an open I-beam floor, with trains passing below on an average of about every seven to ten minutes. Stockyards transit and other trains were passing above about every twenty minutes, dripping their brine and other corrosive agents. The height between the smokestack of the locomotive and the bottom of the I-beams, was not two feet, so one can see that we had exceedingly severe conditions. We found scales on those I-beams that were 3/8 in. thick by actual measurement. The sand blast cut through those quickly, but it required 70 lbs. pressure per square inch to do it. We tried a 20 lb. machine at first, but it acted like yours.

Mr. Killam:—The bridge I refer to is 650 ft. long, with a 225 ft. center span. We had a good deal of difficulty patching it from time to time, but a contract was given a sand blast company to paint that bridge. We had a man stay on the bridge to see that everything was properly cleaned.

The President:—Does anyone else wish to speak on this question of painting bridges and structures? It is a live subject. I am sure we all have our troubles in that direction. I would like to hear from members from different parts of the country, so as to get more varied information.

Mr. Pickering:—I have been listening with a great deal of interest to the discussion. It occurs to me that it is not so much the difference in the temperature that affects our paints on

bridges, as Brother Killam says, as it is the location of the bridge. The major portion of my territory runs along the seacoast and in many places the line is very near the coast. I have another portion of the division which runs up in the mountain districts at a high altitude. I find that the bridges along the coast will need painting about twice, while the ones up in high altitudes only require it once, using the same kind of paint, with the same men putting it on. For this reason I am inclined to think that it is not the changes in the temperature or the kind of paint used, as much as it is the location and the local conditions which affect the paint.

As to the kind of paint used, I am not a chemist and I have not studied deeply enough into this subject to say what I think is best. We are bound to one standard on our road and we use that. I was amused at one thing that was said in regard to lampblack. I want to bear out what Mr. Ettinger said, for just last week I noticed an old sign on a discarded building, which was hard to read except for the fact that the letters were embossed on the sign by the black paint which had been applied on the letters. They had probably been painted over two or three different times. I put my rule flatly on the sign and found that those letters were raised in places more than 1-16 in. above the body of the sign, or, in other words, the body of the sign had worn away; but the black paint had preserved those letters and the surface of the board was nearly as good as when they were first painted. It occurred to me that there might be something in using lampblack.

Mr. Killam:—Someone mentioned using benzine in paint. I would like to know if anyone has used anything of that kind in paint for a dryer?

Mr. Ettinger:—Benzine is not used for a dryer, but is used to cut the material. It is one of the solvents that is used a great deal today. The illustration was merely one to bring out the fact that a great many things are done behind our backs that we don't know about. One will find in this report that the application of turpentine is recommended. That is highly injurious if one uses too much of it, as it destroys the life. Instead of only cutting to produce penetration to enable the paint to get in and bind to the surface, it causes a great deal of trouble with blistering, cracking open and finally falling off. Behind that, one will find a thick film of rust. I can show photographs of an oil-

coated structure erected before the World's Fair of 1893 which had been repainted and repainted until, within the last two years, the entire scale of paint is coming off and hanging down. Behind that there is a scale of corrosion and rust thicker than the paint film. The paint appears all right on the surface but by and by this shrinking effect produces a cracking in the paint film, so that it finally separates and drops off and reveals the trouble behind. Many of our troubles today are due to something we can't see; therefore, we must be very careful in the first preparation. A great many of these defects are due to shop coatings. Very few of us know anything of what has happened before we handle the structure in the field. In six months or a year, sometimes sooner, we find trouble appearing, and forget that some work was done previous to our handling of the structure; consequently, we blame ourselves and try to find the cause of the trouble.

Mr. Alexander:—We all know we take chances in shop painting but the work is not all bad. We had a certain bridge company erect a number of large bridges for us one year and the contract provided that this company was to paint the bridges with two coats after they were up. They erected the bridges in a season when the weather was dry and warm and painted them with two coats of paint in addition to the shop coat, which was already on the chords and other built-up members. They did their work well apparently. I was inspector on the bridges and I could find no fault with the way they were doing it. However the next year those bridges commenced to peel and blister on the built-up members so that they had to be scraped, which cost more than if they had never been touched. We received another bridge after that from the same concern, which they erected in the winter time. The bridge was received with a good oil coating on it and we told the bridge company that we didn't want it to paint any more bridges. We thought we would paint it ourselves. We didn't paint it when it was erected but waited until the next summer, when the season was suitable, when we gave that bridge a good coat of graphite paint with our own painters. As it had a good oil coat before, we didn't give it two coats of paint then. That bridge stood for six years and was in good condition. We then gave it another coat of paint and it stood five years longer without touching again. This was good shop work.

It was voted to allow Mr. Coleman, a member of the American

Society for Testing Materials, of Cleveland, the floor for a few minutes to address the convention on the Theory of Corrosion on Iron and Steel.

Mr. Coleman:—I assure you that I appreciate very much the honor of addressing you, not as the representative of any firm nor as the representative of the American Society for Testing Materials, but purely as a party who is as much interested in the prevention of corrosion and the production of goods to prevent corrosion as you are, both from a practical and scientific standpoint. I have had several years' experience, both in the manufacture of paints and in scientific research, and I am frank to admit that I have never yet seen a scientific investigation that was worth anything without being practically proven by actual tests. The work that I refer to more particularly is work that was started a few years ago by the Institute for Industrial Research in Washington for the purpose of ascertaining what caused rust, and to prove by practical tests the soundness and the value of the different theories that have been exploited for some time past. The theory generally accepted is that rust is caused by electrolytic action.

I know that this morning several things were referred to regarding electrolysis, where live electrolysis was causing rust, but I do not refer to it in that sense, I refer to electrolysis in this case from a chemical standpoint. It is known that when two metals of opposite nature come together, there is a flow of electricity between the two; and dividing these metals into two classes, positive and negative, we always find that when there is a flow of electricity between two metals of that character, the positive metal goes into solution. Iron is one of the most positive metals we run across in ordinary, everyday life. The fact that rust is a combination of iron, hydrogen and oxygen, brings us to the assumption that hydrogen is much more negative than iron. It has been proven that iron must first go into solution in order to rust, that is, become dissolved in water, and we know that we cannot have rust without water.

Up to the present time I do not believe that any paint manufacturer or private individual has found a paint that is an absolute excluder of moisture. Some way or another, in time, it gets in underneath the paint coat, and there, in the presence of hydrogen, which is always present in water in the free state, and in the presence of acids, alkaline pigments or materials of that character, iron goes into solution, oxidizes and becomes rust. That is the basis of the electrolytic theory. The iron first dissolves in water

and there combines with both hydrogen and nitrogen,—the elements of water,—forming rust. The object of my work was to ascertain, if possible, if some method could be devised to prevent this rust. It was found that if certain materials were brought in contact with the iron, which would prevent the formation of hydrogen, they would prevent rust. Hydrogen has an acid character. It is a product that is the base of all acids, so that wherever you have hydrogen, you would naturally expect acids to be present. Thus my first preventive for rust was to use some alkaline pigment. Red lead is one of the most active alkaline pigments we have, and you can readily understand why red lead is such an efficient preventative of rust from the fact that it prevents the formation of hydrogen next to the iron, and without the formation of hydrogen rust cannot form. As a next step it was determined to prevent rust by producing over the coat of the iron some other metal which would render the iron immune to electrolytic action. It was found that certain soluble salts or chromates would prevent iron from being attacked by electricity and while coated with that product there would not be any electrolytic action. Inasmuch as iron always contains iron, manganese, carbon and other materials, there is a constant flow of electricity between them; so the use of zinc chromate, which has lately come into use, has been found very efficient as a rust inhibitor. Test fences at Atlantic City have shown that the old-fashioned vermilion, which is the basis of chromate of lead, was the most efficient rust inhibitor of any pigment and has absolutely prevented the steel from showing any signs of corrosion whatever up to the present time, after two years' exposure. The next matter is to put some metal against the iron which is positive to iron, and in that way, where there is an electrolytic action, that metal will go into solution instead of the iron. I understand that the Pullman Company were using copper and other metals in their window sash, at one time, with the result that the steel of the steel cars went into solution. They changed over to the use of aluminum for those parts of the window sash that came in contact with the iron, because aluminum is more positive than iron and will go into solution quicker. Just how long they have found the window sash will last I do not know, but it does prevent the corrosion of the steel. The next thing is to have a paint next to the steel which contains a rust-inhibiting pigment in some form which is alkaline—as red led, blue lead, orange mineral and things of that character, or such things as graphite and lampblack, which

are very valuable, but not so valuable as those pigments which prevent the formation of rust by some of the means I spoke of before. If the mill scale and things of that character are not removed the product is hydrate of iron and it is electro-negative to the iron itself. Mill scale is also electro-negative to iron itself, so that if rust exists underneath the paint, even though the coat of paint be of a rust-inhibiting character, the existence of a constant current of electricity underneath the paint between the iron and the mill scale will force additional iron into solution, and corrosion will go on underneath the paint without any hindrance whatever. Wherever moisture can get through, corrosion will continue. The necessity is first to have everything that is negative to iron, such as rust and other metals, removed from the surface of the iron and then use alkaline red, blue red or something of that nature or some form of metal which will prevent electrolytic action, such as zinc chromate or American vermilion.

SUBJECT No. 12.

RELATIVE MERITS OF BRICK AND CONCRETE IN RAILWAY BUILDINGS AND PLATFORMS.

REPORT OF COMMITTEE.

The scope of this subject is so broad and the conditions that would tend to determine the merits of either of these materials for any particular place or purpose are so varied that at best only general conclusions can be made. With a view to securing information as to the practice, experience and opinions of the members of the Association and especially those engaged more particularly in building work, a circular letter was sent out and in attempting to systematize the matter, the following general classes of buildings were chosen:

(*a*) Passenger stations, including in this class combination passenger and freight stations.
(*b*) Freight stations.
(*c*) Warehouses.
(*d*) Engine houses.
(*e*) Shops.
(*f*) Interlocking towers and similar structures.
(*g*) Oil houses, tool houses and other small structures of this nature.
(*h*) Other buildings.
(*i*) Cinder pits.
(*j*) Platforms and walks.

While it is evident that each of these classes has points in common with the others, yet each has certain dominating features that serve to differentiate it from the others in determining the choice of materials to be used. There are admittedly other classes of structures, and there are embraced within the first class of buildings, especially, a multitude of styles and a variation of conditions of use, as great, almost, as the differences existing between any of the classes chosen that might influence the selection of material for construction.

Aside from local conditions the following are of most importance in determining the relative merits of brick and concrete for use in any of the above classes of structures:

1st. Comparative cost, both in construction and in maintenance.
2nd. Safety.
3rd. Durability.
4th. Fire resisting qualities.
5th. Susceptibility of alteration.
6th. Adaptability to architectural treatment including the feature of artistic design.

Here again the list of factors that govern in choosing the material for any particular instance might be extended indefinitely and a factor that would practically control the situation in one instance, might be a negligible quantity in another case.

The Committee attempted to collect information regarding the practices with respect to these matters, and to ascertain as far as possible any results either satisfactory or unsatisfactory that would tend to show the

merits of either of the materials to meet the varying conditions imposed upon them in the different groups of structures.

Economy is, of course, the most important consideration and with the increased standardization of structures throughout the country the more permanent structures, generally, prove the most economical. If cheapness of first cost is the controlling factor, or if structures are of a temporary nature, wooden structures should be used. Wooden construction is still the cheapest in all instances, except perhaps on isolated roads so far removed from the sources of timber supply that freight charges make the cost of lumber approximately equal to that of other materials. It is not, however, considered that this subject embraces anything other than a direct comparison of the merits of brick and concrete to meet such requirements as either may be used for and, therefore, any application of one material to uses wherein the other is totally excluded is not considered. As both of these materials are adapted generally only to permanent construction, we have considered this subject as confined to permanent structures.

PASSENGER AND COMBINATION PASSENGER AND FREIGHT STATIONS.

As was stated before, each class of buildings has points in common with the other classes, so that all common points will be treated under this head and only those points applying to individual types will be discussed in the remaining classes.

Either brick or concrete may be used with satisfactory results in the construction of passenger stations. Brick has been in successful use for many years while the use of concrete has been steadily growing for several years. For foundations of all kinds concrete is superior to all other kinds of material as it is cheaper and stronger. By the use of reinforced concrete the bearing area may be increased when necessary without great additional expense. For walls above foundations there is not much difference in cost between plain concrete and good brick construction for the ordinary sizes of station buildings, costing up to $15,000 or $20,000. For one story buildings of this size and where not more than one building of the same size and shape is likely to be erected in any one season on the same division there is little opportunity to effect any economy by using the forms over again.

Where variety of design is desired this can be effected by a combination of brick and concrete in the walls, using concrete for the frame, columns, etc., and brick for the walls, pilasters and general decorative treatment. There will be little if any excess cost in this type of construction and very pleasing results may be obtained. Several railroads have used this type of construction to a limited extent with good results. Care must be taken to maintain good proportions by not allowing too much exposed concrete and to make a judicious selection of colors to obtain pleasing and harmonious results. The building must likewise be adapted to its environment to give complete satisfaction.

Buildings having solid monolithic concrete walls are harder to heat in cold weather than if built of brick, even though air space is provided by furring on the inside. Special precautions must be taken to secure good ventilation to avoid dampness for in wet weather concrete absorbs a great deal of moisture which gives the structure a rather disagreeable appearance. A great deal of dirt will accumulate on the outside walls at such times and much permanent discoloration results. In dry climates this objection does not exist to as great an extent and for this reason as well as from the fact that the natural color of concrete harmonizes with the landscape in dry countries, concrete gives better satisfaction in such climates.

Monolithic walls can be constructed with air spaces and insulation in the walls so that dampness may be kept out and less difficulty is experienced in keeping the rooms warm, but such construction is expensive and not in general use. It could not be recommended for buildings of this type.

Another type of construction that has given good results is the con-

tinuation of the concrete wall above the foundation up to the height of the window sills and the use of brick above. This much of the wall is generally plain and is not cut by openings other than doors, so that it needs no ornamentation or finish. It can be constructed comparatively cheaply and should be placed at the same time that the foundation is placed. This can be recommended as good practice.

The unit construction system or the process of casting walls in sections in moulds laid on the ground and afterwards placing the sections in position by means of a derrick is being developed. It is especially suited to one story structures of large area and of such nature that the walls can be designed to consist of a number of bays of the same size. This method has not as yet been adopted for structures of the size and type of passenger stations, and does not appear to have any advantages for ordinary construction of this type.

On the Wabash Railroad small passenger stations have been constructed in which the walls are built of solid concrete to the bottom of the windows and of frame with cement stucco finish above this. This type has been reported as giving good satisfaction in this class of buildings. Owing to the lightness of the super walls the concrete above the foundation is only nine in. thick. The cost of such a building does not greatly exceed that of wooden buildings having equally good foundations and other features to correspond. Plans of this type and cost as estimated by Mr. A. O. Cunningham, chief engineer of the Wabash, are included in this report. This building possesses the merit of being more nearly fireproof than a frame building. If appearance is considered care must be taken to select a roof in harmony with the

Concrete Passenger Station at Gary, Ind.

walls. On the Wabash metal shingles are used and with satisfactory results. A building of this type 18ft.x42ft. costs about $1400 exclusive of platform.

Concrete blocks properly made can be used to advantage in buildings of medium size. When walls of one thickness of blocks are laid up, the cost is a little less than the cost of brick. The cost of buildings of this sort will be about 30 cents per superficial foot when blocks 8 in. thick are used. There are limitations, however, to this type of construction and to be most economical the building must be designed so that all dimensions shall be multiples

of the size of the blocks used. This type of construction can be carried on in cold weather as well as brick work. Plain blocks having flat surfaces give more pleasing results artistically than blocks moulded in imitation of stone. Concrete blocks cannot be made to look like stone and any attempt to do so results unfavorably. Concrete blocks are subject to discoloration the same as monolithic work and from the standpoint of appearance brick work is superior. Otherwise there is not much choice between the two for use in moderate sized plain structures.

For use in larger buildings, the cost of which exceeds $50,000, splendid results have been obtained by the use of concrete throughout the entire construction. The Lake Shore and Baltimore & Ohio depot at Gary, Ind., is an example of such construction. Such results as were here obtained could not have been secured had brick been used. In this particular concrete passes beyond the field of brick and enters the realm of stone as a building material. This example, however, should stand as an encouragement to the use of monolitic concrete in less pretentious structures.

From the standpoint of safety there is no difference between the two classes of material for use in the walls of passenger stations provided perfect workmanship is exacted in both cases. There is greater danger at the present time of defects in concrete than in brick walls due to lack of experience on the part of the workman, so that when concrete is used thorough inspection must be maintained and the work entrusted only to foremen who understand thoroughly the nature of concrete and how it should be handled. Many of the poor results obtained where concrete has been used are attributable to improper handling of the materials. Owing to the fact that concrete construction has not been carried on long enough, foremen and workmen thoroughly competent to handle it are scarce, while not so much difficulty is encountered in securing competent bricklayers. This condition, however, should not act as a deterrent against the persistent adaptation of concrete to all its possible uses, but should incite caution in the minds of those who contemplate new departures in its use and should impress upon them the necessity of a thorough understanding of all the principles involved in the work to guard against disaster.

From the standpoint of comparative durability there is no choice between concrete and good brick. Concrete in itself would undoubtedly outlive brick in large masses, yet owing to the numerous other factors that determine the life of a building of this sort either material will answer equally well.

The comparative fire resisting qualities of concrete and such brick as may be used in building work is somewhat a matter of conjecture and depends upon the character of the fire. If a building has wooden floors, ceiling and roof timbers, a fire originating on the inside would completely destroy the building in either event. If the building is practically of fireproof construction throughout, a fire such as might occur in the ticket office furniture would not damage either materially. Either type would act equally well as a fire retardent from fires originating outside of the building. Slight fires might be liable to cause the surface of the cement to scale off, whereas brick would not be damaged at all.

Concrete work is not subject to extensive alteration and where alteration is a possible factor of importance brick is preferable.

Considerable has been said about the qualities each of these materials has that lend themselves to architectural treatment. There is no material superior to good brick for use in securing plain, durable and dignified effects. The proper arrangement of brick to give a good appearance to a building need add no expense to the construction. The beauty of many brick stations has been destroyed or seriously marred by the erection of ungainly platforms around the building proper and it is needless to add that if the surroundings of a building are not made harmonious with the structure itself any effort bestowed upon the building will be fruitless. Brick possesses the advantage of many fine colors that lend themselves to varied treatment. Generally speaking the darker and softer colors are most readily adapted to most situations and are never injured seriously by the smoke and dirt that are un-

avoidable about railroad stations. The lighter colored bricks likewise give good results when properly chosen. They seem to be best suited to plain treatment in larger buildings when good straight line effects may be had.

Concrete takes its beauty from its appearance of strength and solidity. Its architectural treatment should be confined to plain surfaces, straight lines and arched effects over doors, windows, etc. Paneling can be used to advantage in some places. Where covered platforms are necessary much better effects can be secured if the sheds are supported on concrete columns arched over to support the roof, so that they have the appearance of a continuous part of the building. If concrete is used care must be taken to avoid placing any ironwork in such position that rust can be carried therefrom over the surface of the concrete by rain for if it is serious discoloration will result.

No attempt should be made to add elaborate details such as ornamental friezes, cornices or capitals to small or medium sized stations. This style of ornamentation adds materially to the cost of the structure and does not improve the appearance. Ornamentation of this character is effective only in larger buildings where massive column effects and other features of this nature can be secured in good relative proportions.

FREIGHT STATIONS AND WAREHOUSES.

For freight stations and warehouses many of the principles applying in passenger stations are found. There is one essential difference, however, in the fact that the buildings are usually larger. Here again brick has been in successful use for many years. The latitude for using concrete, however, is wider than in passenger stations. For foundations concrete is preferable in all cases. For one story buildings reinforced concrete can be used with advantage in columns and girders, while thin curtain walls of brick or cement plaster on metal lath are especially suitable. The unit form of construction is well adapted to this class of structure.

The chairman of your committee would call attention to a concrete warehouse of the Universal Portland Cement Company located on Elston Ave. just north of North Ave. in Chicago that was built in this manner. It is well constructed and probably could not be excelled for this type of construction. The particular advantages of this type of construction are that the units can be cast in these moulds at less expense than in forms erected in place.

If the sections are allowed to harden and cure thoroughly as they should be before being erected there will be no possibility of their cracking as might occur if the concrete is poured in place. The units are securely fastened together when erected. Although requiring a somewhat different equipment, the method of erection involves practically the same operation and costs the same as elevating the wet concrete to pour it in forms erected in place. The fact that the entire side of the mould is open allows more careful placing of the concrete and reinforcement in the thinner portions of the walls.

If it is desired to use concrete floors and roof construction, the columns, frame, pilasters, beams, etc., should also be constructed of concrete. The curtain walls may be either of brick, hollow tile, reinforced concrete, or concrete plaster on metal lath. The latter, however, could scarcely be recommended in buildings when all other parts are of heavy concrete construction as the saving in curtain walls would be a doubtful economy. If wooden floors and roof construction are used, there is little choice between brick or concrete for the walls.

ENGINE HOUSES.

The factors that determine the choice of materials for engine house construction are the same in some respects as they are in other buildings. The experience of most roads has been that their engine houses have been out-

grown and have had to be replaced on account of inadequacy to meet conditions rather than to decrepitude, so that while this condition may not continue to be true of the future to so marked an extent, yet the factor of durability of material is secondary to first cost.

Considerable progress has been made in the construction of engine houses entirely of concrete. When it is desired to go to the expense of making the house essentially fireproof by making the roof, girders and posts of concrete and the use of metal sash and fixtures, as much as possible, then without doubt the balance of the construction should be of concrete. Some objection has been raised to concrete being used in the outer wall on account of the damage that may be done if an engine should accidentally run through. This need not be considered except that the wall should be so constructed that if this should happen the damage would be confined wholly to the curtain wall, and would not extend to the pilasters or beams supporting the roof. If this is done, no greater and probably not as great damage will be done as would occur in a house having brick in ordinary construction in the outer walls. Where concrete is used more opportunity is given for window spaces in the outer wall. As a matter of fact, the entire space between pilasters down to the level of the tracks has been and may readily be utilized for this purpose, as the roof support can be carried above the windows from pilaster to pilaster by means of beams. This form of construction gives room also for considerable economy in the foundation concrete between pilasters. Care must be exercised in designing houses of this kind to properly proportion the foundation to withstand the jarring action of the locomotives passing in and out of the house. The foundations and pits for all classes of construction should undoubtedly be of concrete.

If the interior and roof construction are to be of timber the outer walls above the foundation or at least above the bottom of the windows can be built of sufficient strength more economically of common brick than they can be of concrete. It will be advisable from the standpoint of safety to construct fire walls in houses of this type of more than 15 stalls. These can be built more economically of hollow tile although brick is generally used. When the construction is fireproof throughout fire walls may be omitted, although they will be of advantage in the warming of houses, especially, if they are heated by the hot air system. It is needless to state that greater economy in the use of concrete can be effected in the largest houses admitting of using the form lumber several times.

SHOPS.

Reinforced concrete is particularly well adapted for use in the construction of shop and power house buildings. Either plain or reinforced concrete should be used throughout for foundations, both for the building proper and for the machinery. If the most durable fireproof buildings are desired reinforced concrete should be used throughout the entire construction. A peculiar advantage possessed by this type of construction lies in the freedom from vibration caused by machinery. In one story buildings, especially, curtain walls may be constructed of cement plaster that will answer the purpose as well as solid construction and at less cost. Here also the unit construction method can be followed to advantage as buildings of this class will naturally be designed in bays of identical proportions.

Hollow concrete blocks have also been used to advantage in shop and power house construction. The air spaces in the blocks serve the very useful purpose of keeping out moisture and retaining the warmth, and thus overcome to a great extent two of the most objectionable features of solid concrete in building construction. For buildings of any great size the blocks should be larger than the ordinary blocks and of heavier proportions throughout. The design of the building will determine the proper dimensions, but for walls 25 ft. or more in height the blocks should be at least 12 in. thick. Monolithic foundations should be used and also either monolithic

pilasters should be adopted or solid blocks used to properly carry the load at points where girders and beams are supported. If the blocks are made on the job they can be cast solid. Where some ornamentation is desired window sills, lintels, copings, arches, etc., can be cast solid in moulds with good effect and the walls may be bush hammered. This adds to the cost, of course, but may not be inconsistent. The circumstances in each case and the effect desired should govern the treatment. The Committee considers it proper to recommend that attention should be paid to appearance and proper treatment given in each structure built no matter for what purpose to secure a dignified harmonious aspect, but it does not recommend any "gingerbread" work.

It is our opinion that in the matter of cost of buildings of this class that the outer walls can be built cheaper of common building brick costing from $6 to $8 per thousand and that the use of brick is safer if we consider the possibility of danger from poor workmanship. By the use of concrete foundation, brick walls and cement tile roofs, supported by steel trusses results as satisfactory as could be desired can be had.

For floors in such buildings neither brick nor concrete has proven entirely satisfactory. Creosoted wooden blocks on a concrete base are being tried and seem to be proving satisfactory. In some cases second hand bridge timbers have been cut up and used on a sand or cinder base. These give good satisfaction while new, but do not last as long as could be desired. Mr. Riney, foreman of bridges and buildings of the C. & N. W., who has had a lifetime of experience in this work, recommends wooden blocks on a concrete foundation with a sand cushion between as the most satisfactory type of floor in shops and engine houses.

INTERLOCKING TOWERS.

For interlocking towers either concrete or brick may be used to good advantage. For this class of buildings the most economical construction seems to be the use of solid columns at the corners and light curtain walls between. Concrete is well adapted to this purpose although brick may be used in the same manner. The importance of fire-proofing interlocking towers is a strong factor in their construction and is receiving more attention than formerly.

OIL HOUSES, TOOLHOUSES, ETC.

Buildings of this class can be constructed of either material. For the smaller sizes cement plaster is recommended as preferable to either brick or concrete. Its cost is less and it answers every purpose equally as well as the most expensive solid construction. Cement blocks of the ordinary building size have been used and while good results are obtained, they are more expensive than necessary. For larger oil houses and store houses such as are ordinarily required at important division headquarters, heavier construction is necessary and should be either of brick or reinforced concrete. The floors, foundations and roof should be of concrete, while there is no choice between the two materials for the walls.

OTHER BUILDINGS.

In the construction of office buildings, grain elevators, docks and other structures no general rule can be applied. Concrete is coming into favor for use in the construction of elevators and docks. Brick has never been used to any great extent in either of these cases. All kinds of materials have been used for office buildings but brick is still preferable. There is nothing peculiar about a railroad office building that would differentiate it from any other office building and local conditions and practice will govern largely in the selection of material.

CINDER PITS AND TURNTABLE FOUNDATIONS.

For this class of structures concrete is preferable under ordinary circumstances. Cinder pits should be paved with a good fire resisting brick. Brick will not only withstand the effect of hot cinders and the water used to quench the fire for a longer time, but may also be renewed when it gives out. Cinder concrete has been recommended as not subject to so great disintegration as stone or gravel concrete when subjected to these conditions, but it is the opinion of the Committee that the safer method is to pave the pit with brick. Whether or not the sidewalls should be lined with brick depends upon how severely they are likely to be heated. This will depend upon the size of the pit, and upon whether or not the cinders can be removed before they pile up against the walls. Brick for the entire construction of cinder pits could not be recommended.

Turntable walls and center piers should not be built of brick. Concrete is suitable for this construction. If the pit is to be paved it may be done either with brick or concrete. One feature of turntable construction to be considered is that in the past it has been frequently necessary to replace tables that have become too short before their full life is secured, thus necessitating the construction of new circle walls. If this is anticipated concrete should not be used. In this event it would be better to build the wall of rubble masonry.

PLATFORMS AND WALKS.

For walks the accepted practice where the walks are used almost exclusively if not wholly by pedestrians is a five or six inch cement concrete on a cinder base constructed in accordance with ordinary sidewalk specifications.

For platforms there seems to be a great diversity of opinion. The two principal objections to concrete are that when wet it is slippery and consequently more or less dangerous and that when cracked by frost, falling baggage or other causes it is difficult to repair.

One objection to brick is that a brick platform is likely to become uneven and may cause passengers to stumble and in this way be dangerous. Another is that it is harder to truck over on account of its greater resistance to traction and is more likely to shake baggage off the trucks.

There are three general types of construction in general use in the construction of what may be called permanent platforms.

1st. Vitrified brick on a gravel or cinder base. This base should not be less than 6 in. thick and should be as much as 12 in. under some conditions. Platforms of this type can be built for nine cents per sq. ft. exclusive of curb. Either timber or concrete curb may be used, although concrete is preferable. This type can be recommended for way stations where not more than ten trains per day stop and at suburban stations where a comparatively small amount of baggage is handled.

2nd. Cement platforms 5 to 6 in. thick on cinder filling 6 in. or more in depth. Such platforms cost 13 cts. per sq. ft. To make these safe they should be finished with a wooden float and not troweled. Such platforms will not become slippery even when wet. The greater danger will be experienced when the platform is covered with a light snowfall or heavy frost, but these conditions will make any platform more or less slippery. Concrete curbs should be provided adjacent to the tracks and driveways but they are not necessary elsewhere. Such platforms will serve for all classes of stations.

3rd. Vitrified brick on a concrete base. This type of platform requires a curb and will cost about 16 cts. per sq. ft. It can be recommended only at very busy stations where a great amount of trucking is going on.

None of these types should be used, except on thoroughly settled foundations if it can be avoided. On new embankments some temporary construction should be used if possible. If absolutely necessary to have some better sort of platform the first type is preferable, on account of the fact that the brick may be removed and uneven places leveled up. All these classes

require the same drainage provisions. For large terminals concrete platforms covered with asphalt are used. The cost of the concrete, of course, varies with the depth. The asphalt coating applied about 1½ in. thick will cost 20-25 cts. per sq. ft. It provides a good wearing surface but should not be subjected to any more severe trucking than can be avoided. Rubber tired truck wheels should be used. It is of course possible to mix the mastic so that it will be hard enough to stand severe trucking, but if it is desired to secure a resilient surface for walking on it should be understood that the consistency most favorable for this purpose will not admit of very hard trucking.

Freight platforms can be built most advantageously of concrete. They may be elevated to any height desired. The side supports should be carried down below the level of the ground and safe foundations provided. The interior space should be filled with earth or gravel thoroughly compacted. Most roads, however, still use timber construction; it is cheaper for elevated platforms, especially, and can be renewed from time to time at less expense where second hand bridge timber is available for the purpose. Elevated concrete platforms cost from $.80 to $1.00 per sq. ft.

For miscellaneous platforms for use in coach cleaning yards, etc., where permanent construction is desired concrete is best. These platforms are constructed the same as sidewalks.

GEO. W. HAND,
H. A. HORNING,
G. H. JENNINGS,
PETER HOFECKER,
W. F. STROUSE,
E. M. DOLAN,
D. G. MUSSER,
P. E. SCHNEIDER,
Committee.

APPENDIX.

EXTRACTS FROM LETTERS RECEIVED.

The following are extracts from letters received from members in response to circular letter sent out by the committee:

F. Ingalls, supervisor of bridges and buildings, N. P. Ry.:—We have no buildings, and only one platform, on my division built of concrete. This platform was built some 12 years ago at the Bismarck, N. D., passenger station. It is 16 ft. wide along the track and 700 feet long, and consists of blocks two ft. square on a concrete foundation. It was built by contract at the same time the depot was constructed. We have had quite a little trouble with this platform due to failure of blocks and I am of the opinion that in the near future we will have to replace it with brick, which I think will give better satisfaction than the concrete walk is giving. We have several cinder pits built of concrete and so far they have given very good satisfaction. I am unable to give any detailed cost of same.

A. M. Van Auken, chief engineer, Memphis, Dallas & Gulf R. R.:—Reinforced concrete seems to be the coming form for factory buildings, warehouses and shops. Brick will always be used for many classes of buildings. To my mind the brick curtain wall is as good in a reinforced concrete frame building as concrete. A form of construction has been used quite largely on the Wabash and Kansas City Southern which when the cost of the building is an item seems to be in advance of anything so far developed. On the Wabash the building is of solid concrete to a height of about five ft. above the platform, above which is a wooden frame covered with cement plaster. The roof is covered with tin shingles, making a very handsome building, which costs about the same as a wooden station with shingle roof,

well painted. The Kansas City Southern building is similar, but is covered with a prepared roofing felt. It would seem that these are worthy of the study of those wishing a cheaper form of construction than solid brick. In considering the brick veneer the fact should never be overlooked that there is no possible way of securing any union between the wooden frame and brick shell and that the brick merely takes the place of wooden weatherboarding. As the brick has not the strengthening power for the frame, which weatherboarding has, it is necessary to make the frame stronger or the building will soon shed its covering of brick. Brick seems superior to concrete for station platforms. A concrete platform will develop holes under the impact of falling trunks and freight and it seems impossible to patch a hole in a concrete platform so it will remain and the hole grows steadily larger.

R. J. Bruce, superintendent of buildings, M. P. Ry.:—We have several buildings, including a roundhouse and power house built of concrete, also two tank supports, neither of which shows any economy, the latter being much more expensive than even steel supports. We have also built several smaller buildings such as oil houses, etc., generally at outlying points where bricklayers were not available. Where brick fit for building purposes can be secured for $4 per thousand for backing and from $7 to $9 per thousand for face, I see no economy in concrete buildings when built according to present methods. The durability of brick is well known while that of concrete is yet to be demonstrated. There is more chance for fraud in concrete construction than in brick. Reinforced concrete will stand more fire than ordinary concrete. In case of fire ordinary concrete walls will suffer as much as brick, but there will be some salvage from brick while concrete will cause more expense in tearing out with no salvage. Brick offers the best opportunity for remodeling. Concrete buildings for railroads will become economical and practical only after a full set of standard plans are made and with a view of economy in building forms and after the unit plan rather than monolithic is adopted. Stations could all be built on the same architectural plans, with the sizes regulated by the number of different units, and the same may be said of all buildings. I see no economy in building a frame wall, filling it with concrete and then tearing down the frame. When the body is large, such as in foundations and piers, the form charges do not enter into it so heavily.

F. C. Osborn, civil engineer, Cleveland:—In our opinion concrete and reinforced concrete can with advantage be used in all of the structures under consideration by the committee, so far as the frame work of the building is concerned, at least. We do not think it advisable to use concrete for the entire construction except perhaps in a few cases. Passenger stations, and even freight stations and warehouses as well as, in many cases, engine houses and shops, can be built at as low cost with as great durability and fire resisting qualities, with greater susceptibility of alteration and with considerably greater adaptability of architectural treatment when built of reinforced concrete frame, columns, girders, floors, roofs, etc., with brick walls, pilasters and decorative treatment.

Such small buildings as interlocking towers, light houses, tool houses, etc., can be more advantageously built with reinforced concrete frames and walls constructed of Portland cement plaster on some form of metal reinforcement. Brick is obviously unsuited to such work in most cases and concrete, except for the frame, is unnecessary.

F. E. Schall, bridge engineer, Lehigh Valley R. R.:—In my opinion the preference should be given in the following order:

Brick.

Brick alone or in combination with plain stone trimming such as lintels, sills, copings, etc., is particularly susceptible for a plain, durable and dignified treatment. In combination with cut stone or terra cotta, mouldings and ornamentation, brick is particularly good and susceptible of any desired artis-

tic treatment, especially if good judgment is exercised in the selection of the various grades, colors and shapes of brick now on the market. As to durability, maintenance and freedom from serious discoloration by the elements, brick should rank as No. 1.

Hollow Tile With Stucco Finish.

Hollow tile as now manufactured for the building trades is made in an almost unlimited number of forms for walls, partitions, sills, window jambs, window lintels, etc., and in combination with concrete and reinforcement it should rank as the very highest where a moderate sized building is contemplated, with the required features of moderate cost, fire retarding qualities, maintenance, and a reasonable amount of artistic treatment. Also in combination with brick, stone or terra cotta, some of the most artistic houses, stations, etc., in the country have been built. However, tile is particularly liable to discoloration from the elements or various other causes such as efflorescence, unequal grades of cement or aggregates used in the stucco, and it is almost impossible to remedy this except by the application of some of the various paints now made for this purpose. As this is expensive and also destroys the texture of the original soft effect of the stucco finish in a short time it invariably leaves a very unsightly looking structure. At the same time this is rather an expensive proposition, for maintenance after the original outlay, especially if the appearance of the structure is to be considered.

Concrete.

Concrete is so well known that there is little to say except that it must be confined to straight lines as far as possible in building work if a reasonable expenditure is contemplated. All attempts at ornamental treatments with concrete itself are more or less expensive according to the design, especially if tooled, washed, or bush hammered. The same objections to discoloration apply as for stucco work. Where no ornamentation is desired, but a plain neat fireproof building is required for a warehouse, tool house, signal tower, freight house, etc., it is particularly desirable from a maintenance standpoint, if the susceptibility to discoloration is not to be considered.

W. F. Strouse, assistant engineer, B. & O. R. R.:—The class of material used in railway structures should always depend upon the purpose for which it is to be used, whether temporary or permanent. If the work is to be of a temporary nature concrete should not be used under any circumstances and brick only should be used to meet city ordinances bearing on fire restrictions or insurance requirements. In razing concrete structures practically no salvage can be counted upon, while brick structures will net 30 per cent or more of the original value of the material. Permanent railroad structures should generally be built larger than the business at the time would seem to warrant, as it frequently outgrows the structure long before renewal is necessary. This is especially true in engine houses which cannot well have the spans increased to meet the increased length of locomotives. The same is true in a less degree in both freight and passenger stations, which are seldom designed to provide for future extensions.

While there is a steady growth in the use of concrete for railroad structures, I feel it will never replace brick as a general building material, but that we will find a combination of the two preferable. The use of concrete in foundations will undoubtedly increase, but more satisfactory results will be obtained by the use of brick for all exposed walls. The use of concrete floors in certain kinds of buildings, particularly where the service is severe, has gained considerable headway; but creosote blocks are likely to replace concrete for this purpose.

In the construction of roundhouses concrete is used very extensively in the foundations, pipe ducts and fire and drop pits; but outside of some re-

- Lehigh Valley R.R. Passenger Station, Cortland, N.Y.
  - Construction,
    - Foundations, Concrete.
    - Side walls, Hollow tile, cement stucco finish.
    - Partitions, Hollow tile.
    - Floors,
      - First floor, concrete and Terrazo.
      - Second floor, wood.
    - Roof, Timber construction.
    - Roofing, Tile.
    - Interior Finish
      - Walls and ceilings, plastered on plaster board.
      - Trim, 1st floor, chestnut.
      - " 2nd " N.C. pine.
  - Size,
    - First Floor, 25'x 109'
    - Second " 28'x 31'
  - No. of Stories, One with small 2nd floor over tkt. ofs.
  - Cubic contents, 77,000 ft.
  - Platforms, Concrete,
    - Area, 7350 sq. ft.
    - Cost, @ 17¢ = $830.
  - Fire Protection,
    - Stand Pipes, 1st to 2nd floor.
    - Supply, City pressure.
  - Fire Resisting Qualities.
    - Fair.
    - Probable loss by Fire,
      - Practically all except foundations and possibly part of walls.
  - Cost,
    - Total, $19,000, exclusive of platforms.
    - Per cu. ft., Abt. 24¢, inc. canopy at end.
    - Per sq. ft., $6.50 exclusive of platfms.

Lehigh Valley Railroad. Passenger and Freight Station. MILAN, PA.

- Station Portion,
  - Construction
    - Foundations, Concrete
    - Side Walls, Hollow Tile.
    - Partitions " "
    - Floors, Concrete.
    - Roof, Timber.
    - Roofing, Roofing Paper.
  - Size, 19.5'×28'
  - No. of stories, 1.
  - Cubic contents, 9800 ft.
- Freight House,
  - Construction
    - Foundations, Concrete.
    - Side Walls,
      - Hollow tile filled to a ht. of 6' above floor with Concrete.
      - Cement plastered ea. side.
    - Floor, Concrete.
    - Roof, Timber.
    - Roofing, 2 ply Paper.
  - Size, 19.5×24'
  - No. of stories, 1.
  - Cubic contents, 8400 ft.
- Platforms,
  - Freight House
    - High platform, concrete reinforced with ½" φ rods.
  - Station, Concrete.
- Fire Protection
  - Station, Standpipe.
  - Freight House, Hydrant.
- Fire Resisting qualities.
  - Fair.
  - Probable Loss by fire,
    - Roof, Windows and doors.
- Cost,
  - Total, $ 3,600.
  - Per cu.ft., about 20¢.
  - Per sq.ft., " $3.50

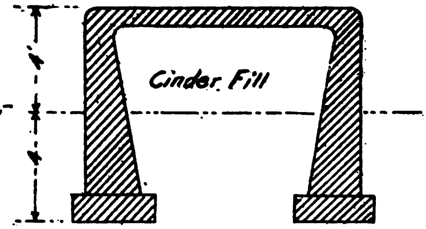
- Lehigh Valley Railroad, Freight House,* So. Bethlehem, Pa.
  - Office portion,
    - Construction,
      - Cellar Walls, Concrete.
      - Foundations, "
      - Side walls, Hollow tile, cement plastered.
      - Floors, Wood.
      - Roof Trusses, Timber.
      - Partitions, "
      - Roofing, Slag.
      - Inside Finish, Plastered walls, wood trim.
    - Size, 45' x 54'
    - No. Stories, 2.
    - Cub. Contents, 80,000 ft.
  - Freight House,
    - Construction,
      - Foundations, Concrete.
      - Outside Walls, "
      - Fire Walls, "
      - Floors, "
      - Roof, Timber.
      - Roofing, Slag.
      - Canopy overhangs, Timber.
    - Size, 59' x 254'. (Irregular in shape.
    - No. Stories, 1.
    - Cub. Contents, 450,000 cu. ft.
  - High Platform,
    - Construction,
      - Ret. Walls, Concrete.
      - Filling, Cellar dirt and Cinders.
      - Floor, Concrete.
      - Reinforcement, ½" ϕ rods.
  - Fire Protection,
    - Fire Walls, 3 of concrete with automatic doors.
    - Hydrants, Inside freight rooms.
    - Stand Pipes, In office, cellar to 2nd floor.
    - Supply, City Pressure.
  - Cost,
    - Total, $35,000.
    - Per cu. ft., 6 7/10 ¢.
    - Approx. Sub-divid.
      - Office, per cu. ft. 12¢.
      - Frt. House, " " " 5 7/10 ¢
      - Platform, per sq. ft., 85¢
  - Fire Resisting Qualities.
    - Office,
      - Fair, from outside fire.
      - Probable loss, all above foundations.
    - Freight House,
      - Very good.
      - Probable loss, Roof and Windows.

Lehigh Valley Railroad. Reinforced Concrete Roundhouse at Coxton, Pa.

- Number of stalls, = 16
  - Size of each stall
    - Inside circle, 13.29'
    - Outside " 23.75'
    - Length, . . . 90.
    - Angle, . . . 6°-40'
  - Area, 26,640 sq. ft.
  - Cubic contents, 626,040 ft.
- Construction
  - Foundations, concrete, 1:3:5 stone
  - Columns, " 1:2:4 "
  - Roof beams, " " " "
  - Roof " " " "
  - Side curtain walls, Hollow tile plastered.
  - Floor, Concrete.
  - Windows, wood.
  - Doors, rolling wood shutters.
  - Jacks, Concrete
  - Reinforcement
    - Columns and beams, ϕ rods.
    - Roof, ϕ rods and exp. metal.
    - Side walls, none.
    - Jack and smoke curtains, ϕ rods and exp. metal.
    - Ventilators, " " "
- Fire Protection, - None provided
- Fire resisting Qualities.
  - Fire-proof / Probable loss by fire
    - Doors and Windows — About 8% of total cost
- Cost
  - Total, $50,000.
  - Per stall, 3,125.
  - Cu. ft., about 8¢
  - Sq. ft., . . . $1.87
  - Exclusive of heating, Lighting and Piping

Platforms:-

High Frt. Platforms;-



Cost reinforced about 75¢ to $1.00 per sq. ft.

Low Station Platforms;-
Cost about 15¢ to 19¢ per sq. ft.

Transfer Platforms:-

Lehigh Valley Railroad. Manchester. (Proposed)

- *Construction,*
  - *Substructure, concrete reinforced.*
  - *Superstructure, Steel frame, wood roof. Prepared roofing.*
  - *Buildings, Hollow tile, plastered.*
- *No. of platforms, three.*
- *Size of " 25' x 800'*
- *Area of 3 " 60,000 sq. ft.*
- *Cost,*
  - *From contractors est., about $73,000, exclusive of buildings.*
- *Cost, per sq. ft., about $1.21*
- *Total cost, Including office, bunk room, coal room, Supply rooms; cellar, heating, lighting, scales, water supply, etc., about $90,000.*
- *Cost per sq. ft., about $1.50.*

inforced concrete lintels the sills, exterior walls and fire walls are generally built of brick. Oil houses and terminal storehouses should be constructed of a combination of brick and reinforced concrete, both from a standpoint of durability and for fire resisting qualities.

Cinder pits can be built to very good advantage of concrete except that those portions which come in contact with hot cinders should be lined with vitrified brick, as the sudden chilling, when wetting down the cinders, is liable to cause considerable injury to the concrete if not protected by brick-work.

Brick platforms with concrete curbs are now used very extensively at smaller stations and at points where changes are likely to be made, as alterations can be made in brick platforms with comparatively little loss of material. Concrete platforms are preferable in the larger stations where large trucking is done and where they are covered. Platforms of either brick or concrete are dangerous when covered with snow or ice, but brick platforms are rougher than concrete and consequently preferable where exposed. In the ordinary platform there is little difference in cost between brick and concrete, for what is saved in the brick work is lost in the cost of concrete curbs which must be used, while concrete platforms, in many instances, can be constructed without the use of curbs. This is especially true in coach cleaning yards where a platform, say five feet in width, can be constructed between the tracks on top of the cinder ballast, bringing the top of the platform to the same elevation as the top of the rail, the cinders having first been thoroughly compacted to the top of the tie.

In regard to the relative cost of brick and concrete construction it is found that the cost of forms for concrete in most instances, offsets the saving in cost of the material, particularly when the walls are thin and architectural treatment is considered. If properly constructed, one material should be as safe as the other. While we have no definite information, a good quality brick structure should outlast a similar structure of concrete.

The fire resisting qualities of brick are greater than those of concrete, on account of the deterioration of most kinds of stones when subjected to intense heat. The Baltimore fire, however, demonstrated the fact that good reinforced concrete will withstand severe heat with little damage. Concrete is not so susceptible of alteration as brick. New concrete does not bond well with old and it is extremely difficult to effect harmony in color. Concrete, if damaged by having the edges or corners knocked off, is very difficult to repair, while brick work can very readily be repaired by replacing the damaged brick with other brick of the same character and quality. Brick work responds more readily to artistic design in architectural treatment than concrete, except in the plainer orders.

R. P. Mills, supervisor of buildings, and C. C. Warne, assistant division engineer, N. Y. C. & H. R. R. R.:—The use of concrete for passenger stations and combination passenger and freight stations on the territory coming under our jurisdiction has been mainly restricted to foundations, or that portion of the buildings below the floor sills. In a few structures, the side and end walls have been built of concrete from the bottom of the foundation up to the under side of the windows. We use 1:3:6 crushed stone concrete which can be placed for about $6 per cu. yd., the cost of the stone being 75 cts. per yard at the crusher. Our price per cubic yard includes the handling of the material, building of the forms, mixing of the concrete, and the placing and removing of the forms. The concrete is usually mixed by hand. To obtain a good surface, it is usually spaded alongside the front form, and when the forms have been removed all rough spots are reduced by floating. For this purpose we use a cement brick made on the job. We can also obtain a rustic effect by using pebbles in the concrete. These pebbles are used in the face of the concrete only. In placing them a steel plate is used with ribs attached, allowing a space of about 1 in. between the form and the plate. In this space the pebbles and concrete are placed. The remaining concrete is placed against the back of the plate, which is raised as the work proceeds. We take the form down when the concrete is a little green, and remove the concrete from between the pebbles with wire brushes, exposing them. The additional expense for this we find to be about $2 per cubic yard. We find

concrete for this purpose very satisfactory and would always use it in preference to brick. As we have never used concrete for the body walls of a building, with the exception noted, we can give no comparative figures covering the cost of construction and maintenance. From our observation of the wearing qualities of concrete and brick, we believe they are about equal, so that from the standpoint of the cost of renewals, we believe the item of maintenance can be eliminated. If the surface is to be painted, which is sometimes done, it would seem to us that the paint would last longer on a concrete surface and that a smaller quantity will be required per sq. yd. on account of less absorption.

We would consider concrete safer than brick for foundations because a mass of concrete is stronger than a mass of brick work, and is less liable to crack on account of uneven settlement. Where soft soil is encountered, it is a simple matter to re-inforce the concrete with old rails or rods, making a very strong type of construction, which will distribute the pressure over a large area. With brick work, this form of construction cannot be obtained. As far as the walls of the building are concerned, providing that the foundations are stable, it would seem that the relative difference in the strength of the two materials would be of no consequence. The materials are about equal in durability.

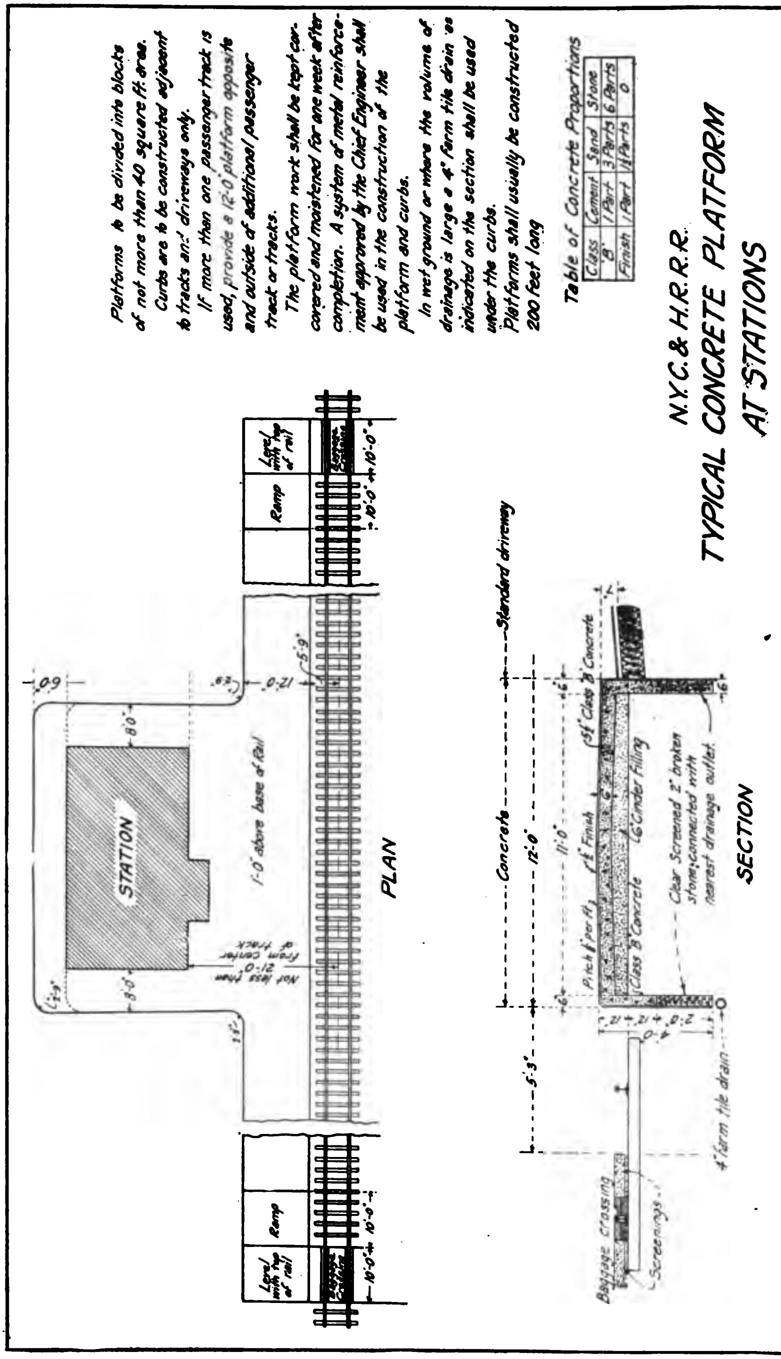
Brick work has always been known as a good material to resist the action of fire, and it is extensively used in fire-proofing buildings. It seems to us that brick work would offer more resistance to fire than crushed stone or gravel concrete. We have seen some cases, however, where concrete has been subjected to very severe conditions, and one especially in the burning of a coaling station. The foundations of this building were covered with burning coal for a number of days, and when uncovered, the concrete was found to be in first-class condition. However, if we expected concrete to be exposed to the action of fire, we would recommend the use of cinders in place of natural stone or gravel.

We have found it much easier to cut holes in brick than in concrete walls, also in tearing down sections of walls for placing windows, there is a better opportunity for obtaining a bond between the old and new work. The great difficulty in joining a mass of fresh concrete with old concrete is that owing to the shrinkage of the new concrete, a crack will likely occur at the junction.

Both concrete and brick can be used to obtain fine architectural effects, only on somewhat different orders. With concrete, large masses can be formed ornamented with carvings or figures. Massive lintels and sills give a very good effect. In fact concrete is subject to about the same architectural treatment as stone masonry. With brick work, the architectural features are restricted to arches, corbeled brick, geometric figures, and differently colored brick work, proper combinations of which are very pleasing. In comparing the two materials a great deal rests upon the individual's taste.

What we have said in regard to passenger stations will apply generally to freight stations and warehouses on our territory. These stations have been built entirely of brick, and we consider this a very satisfactory material.

The engine houses which we have constructed have been built of brick, although we think that concrete could be used to good advantage for this type of structure. We think that concrete might be a more durable material. We found in tearing down the walls in our old engine houses that the gases seem to have affected the brick work, making it rotten. We do not think gases would have the same effect upon concrete. We believe concrete can be used very well for roofs of engine houses and shops; for these re-inforced concrete would give a very durable roof. In so far as brick work has never been used for this purpose, the use of re-inforced concrete would hardly come under this discussion. In the consideration of a roof of this character, there is one thing that should not be overlooked, and that is the condensation of vapors and gases, causing drippings which are annoying to the workmen and hard on engines and tools.


STATION
PLAN
SECTION
1-0" above base of Rail
Not less than 21-0" from center of track
Level with top of rail
Ramp
Concrete
Standard driveway
Pitch ⅛" per ft.
⅛" Finish
5½" Class B Concrete
Class B Concrete
6" Cinder Filling
Clear Screened 2" broken stone; connected with nearest drainage outlet.
4" farm tile drain
Baggage crossing
Screenings
Platforms to be divided into blocks of not more than 40 square ft. area.
Curbs are to be constructed adjacent to tracks and driveways only.
If more than one passenger track is used, provide a 12-0" platform opposite and outside of additional passenger track or tracks.
The platform work shall be kept covered and moistened for one week after completion. A system of metal reinforcement approved by the Chief Engineer shall be used in the construction of the platform and curbs.
In wet ground or where the volume of drainage is large a 4" farm tile drain as indicated on the section shall be used under the curbs.
Platforms shall usually be constructed 200 feet long
Table of Concrete Proportions
Class | Cement | Sand | Stone
"B" | 1 Part | 3 Parts | 6 Parts
Finish | 1 Part | 1½ Parts | 0
N.Y.C. & H.R.R.R.
TYPICAL CONCRETE PLATFORM AT STATIONS

We believe a stronger cinder pit can be built of concrete, especially on soft ground, from the fact that concrete can be re-inforced with old rails. Where the foundation is good, one material is about as good as the other. We find that with brick pits, it is almost impossible to keep the mortar between the bricks, as it is jarred out by the vibrations of the moving engines. We experience no trouble of this kind with concrete. As concrete has been used only in the last ten years, we have no case where we have been able to compare the life of a concrete ash pit with a brick pit; we think that concrete will last just as long. If concrete is made with cinders instead of natural stone or gravel, it will resist fire as well as and probably better than brick work.

We have not constructed any platforms or walks out of brick within the last ten years, having used concrete exclusively for this purpose. We can build a concrete platform or walk for about 13 cts. per sq. ft. When well laid, we find the cost of maintenance to be practically nothing. A concrete platform is much easier to keep clean than brick. Also if brick work is not given a great deal of attention, weeds and grass will grow between the bricks. When the surface of the concrete is properly roughed in finishing it gives a safe surface. Unless the brick is laid on a concrete sub-base, the bricks are liable to settle unevenly, making the surface somewhat rough, which might cause passengers to stumble by striking their toes against the raised brick. We believe that concrete platforms will last longer than brick.

There is one thing to be taken into consideration in the use of platforms which is not covered by the different headings already discussed, and that is the resistance to traction in the hauling of baggage trucks over the platforms. We believe the concrete surface offers much less resistance to the baggage truck than brick, and for this reason heavier loads can be drawn. When trucks are drawn over brick work, they are jarred to a considerable extent, which frequently causes baggage to fall off the trucks. A truck is more difficult to control on a brick surface than on one of concrete.

A. Montzheimer, chief engineer, and Geo. H. Jennings, superintendent bridges and buildings, Elgin, Joliet & Eastern Ry.:—We have no brick or concrete passenger stations as the E. J. & E. is strictly a freight road. Our stations are no more than offices and freight houses. We have a concrete block office building used by one agent at Buffington, Indiana, the foundations being monolithic and the walls above the foundations being hollow concrete blocks. Previous to the adoption of concrete for general building construction we used brick, the average thickness of walls being 13 in., composed of a facing of Hobart, Ind., pressed brick and backed with Chicago common brick. A wall of this description will lay up about 18 bricks per superficial foot, and will cost on an average $17 per M., laid in the wall. This makes the cost of brick walls of this description 30.6 cts. per superficial ft. The concrete blocks are 8 in. thick and arranged to lay in stacks so as to provide ample ventilation at all times. They cost 30 cts. per superficial foot laid in the wall, including the cost of making the blocks and all materials. The only objection that has been raised against the use of concrete walls for buildings is the dampness on the inside of the walls. Whenever this dampness appears, it is due to improper construction of the blocks, or to insufficient ventilation. Care should be taken to procure blocks that provide for at least a 1 in. air space or greater at all points in the wall.

We had occasion to build a fireproof vault of these hollow concrete blocks and after it was completed and plastered it seemed impossible to get it dried out. The roof was of monolithic reinforced concrete, covered with prepared roofing. This roof dripped continually and the plaster was not hard at the end of three weeks. We installed two cast iron gratings or ventilators on opposite sides of the vault, against the soffit of the cornice, and the vault became dry in two days. It has given no trouble since. This simply illustrates that concrete is cheaper, and just as desirable as brick, for building purposes, provided the walls and the building are properly ventilated.

The cost of concrete block construction for the vault mentioned above was as follows:

12 cu. yds. limestone screenings at .$60,	$ 7.20
12 cu. yds. torpedo sand at $.50,	6.00
75 sacks cement at $.3625	27.19
Labor making and handling blocks to job	68.00
Cost of laying blocks in wall	59.00
	$167.39

Above cost includes all scaffolding necessary, but does not cover any cost for rental of machinery for making the blocks, as we borrowed the machinery, no charge being made for it. In case rental or royalties have to be paid, this price should be increased accordingly.

There were 584 superficial feet in the walls of this building. This represents a cost of 28.6 cts. per superficial foot. The average size of these blocks was 10in.x23¾in.x7¾in. Allowing for ¼ in. joints, each block would lay 10¼in.x24in. face, the thickness of wall being 7¾ in. In using this style of block the inside of the walls must be furred before the lath and plaster are put on.

Below is given a statement of the cost of manufacturing and laying blocks for a pump house and gas engine building at the Illinois Steel Company's plant. This cost is divided into four items, the construction of the plant, the cost of manufacturing the blocks, the cost of erection of the pumping house and the cost of erection of the gas engine electric station.

To the construction of the plant was charged the cost of clearing the ground, erection of the machinery and storage bins and the purchase price of cars and pallets for handling the blocks. The block machine and the mixer were not purchased but were rented at a rate of $60 per month. This rental is charged to the manufacturing cost. The cost of manufacturing blocks is divided into the cost of material and cost of labor.

To the erection of the buildings was charged the cost of handling the blocks from the stock pile to the buildings as well as the cost of laying them. In comparing the cost of these blocks with that of common brick, it was considered that one standard block was equivalent to 16½ common brick, as each block lays up ¾ of a cubic foot when laying a 12 in. wall.

The price given in the accompanying table is a little high on account of having to install such an elaborate plant to carry on the work properly. These blocks are 9in.x24in. and the thickness of the wall 12 in. This style of block provides for an air space throughout the entire length and height of the wall, the smallest air space through the center of wall being 1 in. wide.

COST OF CONCRETE BLOCKS FOR BUILDING PURPOSES.

Data Secured in the Construction of a Pump House and Gas Engine Building at the Illinois Steel Company's Plant.

(The figures in the right hand column represent cost per block.)

Construction of Plant.	Amount.		
Freight on machinery	$ 39.90		
Transfer cars,	732.28		
Erection of machinery,	427.25		
Electric wiring,	16.08		
Steam drying room,	378.07		
Storage bins for cement and slag,	165.85		
Stock of wood pallets,	502.53		
Steam and water piping,	102.41		
Clearing ground,	144.86		
Miscellaneous construction charges,	85.88		
Tracks,	143.11		
Total construction charge,		$2,738.22	.0678

MANUFACTURING MATERIAL.

Rental of machinery,	$ 240.00		
Cement, 971 bbls. @ 1.246,	1,210.00		
Limestone screenings, 577 yds. @ .198,	114.28		
Sand, 130 yds. @ .530,	68.87		
Steam,			
Water,			
Electric light and power,	70.37		
Forms for special shapes,	13.65		
Repairs,	25.97		
Miscellaneous supplies,	15.14		
Scrap for reinforcement,	43.35		
Total,	$1,801.63		

LABOR.

Superintendence,	$ 402.50		
Labor making blocks,	1,055.33		
Handling from machine to storage pile,	254.25		
Miscellaneous producing labor,	45.15		
Repairs,	162.14		
Total,	$1,919.37		
Total manufacturing cost,		$3,721.00	.0921

ERECTION OF CONCRETE BLOCK BUILDING WALLS.

AQUEDUCT INTAKE PUMP HOUSE.

Loading blocks into cars,	$ 41.48		
Handling from cars to building,	58.45		
Staging and platforms,	151.49		
Labor laying blocks,	553.05		
Miscellaneous supplies,	44.92		
Switching charges on blocks,	6.00	$ 855.39	.1375

ELECTRIC STATION.

Loading blocks into cars,	$ 180.66		
Handling from cars to building,	174.57		
Staging and platforms,	1,103.70		
Labor laying blocks,	1,972.86		
Miscellaneous supplies,	239.69		
Switching charges on blocks,	63.00	3,734.48	.1434
Total cost of laying blocks,		4,589.87	.1422

Number of blocks made,	40,409
Number laid in pump house,	6,220
Number laid in gas engine house,	26,049

The foundations for the buildings on the E. J. & E. are all of concrete, and when put in place with the balance of the buildings not requiring a special movement of a bridge and building gang, cost us $5 per cubic yard, including cost of material, forms complete and all labor. We have two ¼ yard Smith mixers, mounted on wagon trucks with a steam boiler and engine that we use for this purpose. These mixers are light and can be unloaded and loaded by hand on a flat car. They can also be moved about on the job to convenient points, avoiding much wheeling. An ordinary gang of eight men and foreman can mix and place 50 to 60 cu. yds. of concrete per day of ten hours with one of these outfits, the output depending on the distance that the concrete has to be wheeled.

We have made experiments with these mixers and have found that we can save $1 per cubic yard on each yard mixed compared with mixing by hand. Of course the job must be large enough to warrant use of mixer. We use mixers on all jobs of over 25 cubic yards, and obtain better concrete than can be mixed by hand at a greatly reduced price.

Our standard ingredients are crushed washed gravel, washed torpedo sand and Universal Portland cement; the detailed cost of one yard of concrete is as follows:

1 cu. yd. crushed washed gravel,	$ .40
½ cu. yd. washed sand,	.25
1 bbl. Universal Portland cement,	1.50
Labor per cu. yd. mixing and placing,	.44
Freight and form work complete,	2.41
	$5.00

In reference to maintenance, we have found that buildings made of concrete can be maintained at a less cost than brick buildings laid with lime mortar. We are obliged from time to time to point up our brick buildings; also to remove and relay portions of walls when frost has affected brick. We have experienced no trouble with concrete due to the action of frost.

We consider concrete safer for any description of building work than brick, provided the same is properly designed and executed. Monolithic concrete cannot be handled as safely as brick work in freezing weather. We have, however, placed reinforced concrete in very cold weather that turned out to be perfect. It is very expensive to handle concrete in freezing weather, and we do not recommend it, as frozen concrete will fail sooner than from any other cause.

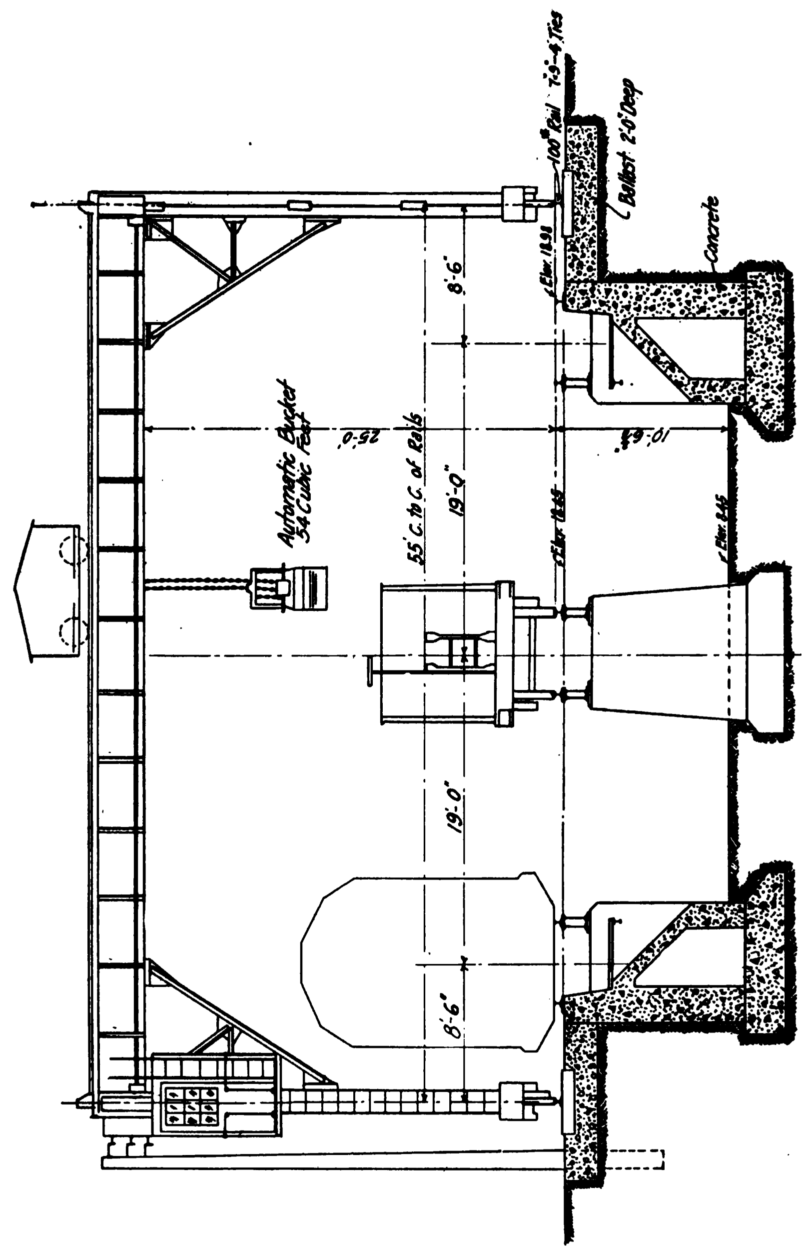
Where concrete blocks are made and properly cured, they can no doubt be laid in cold weather as safely as brick, as brick work requires more joints per superficial foot of wall than concrete blocks.

By using reinforced concrete in foundations the loads can be distributed over greater areas than is possible with any other type of construction. This represents great economy where heavy loads are to be supported on insecure footing.

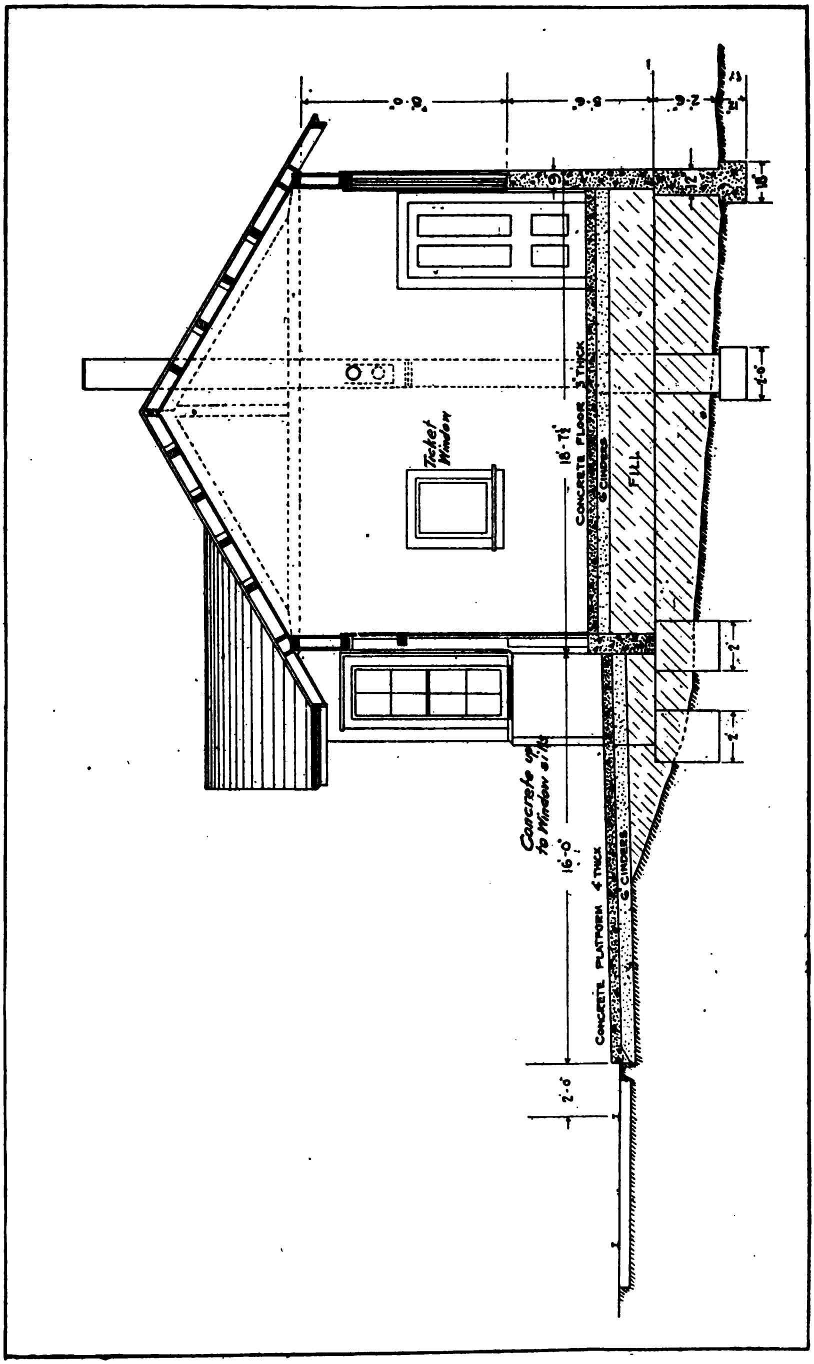
We have been using concrete for building purposes for the past five years, and have had no failures; neither have we observed any indication of deterioration.

Our experience is that brick will resist fire better than concrete. Excessive heat will cause concrete to crack and crumble. We base this statement on our experiences with concrete cinder pits. We had an explosion and fire in our storehouse at Gary some years ago, which might be of some interest. This building is constructed of brick side walls, steel roof trusses and purlins, with a 4 in. monolithic reinforced concrete roof, covered with tar and gravel. Shortly after this building was completed, spontaneous combustion caused a fire in the fusee storage; this spread to the torpedoes, a large stock of which was stored adjacent to the fusees, causing a tremendous explosion that filled the entire building with fire. Several panels of the brick walls were blown out and the entire roof raised from the purlins at least six inches, but it settled back into place without cracking the concrete at any point. Short pieces of 2x4 timbers, rolls of paper, bolts, etc., were blown between the purlins and roof while the roof was in the air, and some of this material can be seen at this time, located as described above. The fire did not damage the roof except directly over the point where the explosion occurred, where about 1 in. of the under portion of the roof scaled off about two or three ft. square.

It is easier and cheaper to alter brick work in any class of building than concrete. Brick walls can be taken down and the same bricks used in rebuilding, whereas a concrete wall is a total loss if taken down, and is much more difficult to handle. It is also very difficult to refinish the wall where an opening is made in concrete work.



Cinder Pit with Gantry Crane at Gary, Ind., C. L. S. & E. Ry.



Combination Depot at Naples, Ill., Wabash R. R.

We believe that with the proper treatment of concrete the same results can be obtained as with granite, marble, Bedford stone, brick or any other building material.

With reference to interior work, the offices of the Universal Portland Cement Company at Buffington, Ind., are finished inside, including the stairs, hand railings, floors and ceilings, in concrete. The ceilings are all made as follows: Beams were cast about 4 ft. center to center of reinforced concrete, being exposed on three sides. The faces of these beams were colored to match the balance of the room. On these beams concrete slabs were laid with the exposed side polished, the slabs being made of various kinds of stone screenings to give different colors. This makes a beautiful ceiling, resembling polished marble. The stairs, hand railings, etc., were cast and treated like the slabs.

We have adopted reinforced concrete as a standard for all our roundhouses. At the present time we have three of these houses in service, and one under construction.

Our roundhouse at Waukegan, Ill., is a 15 stall monolithic reinforced concrete house, except the roof, which is composed of reinforced concrete slabs. This building is composed of concrete throughout, including the floors, pits, foundations and walls.

A reinforced concrete extension in the rear of the house is used as a machine shop which should be treated as one additional stall in arriving at the price per stall. The entire building, except the slabs for the roof, was poured in place on the job, including all beams and columns. The slabs were made in Chicago, shipped to Waukegan on cars, and placed with a derrick. A five ply tar and gravel roof was then put on. A saving of $1,000 was made on this building by using unit roof slabs.

At East Joliet we have in service a 17 stall reinforced concrete roundhouse, the construction of which is the same as the 15 stall house at Waukegan, except that the entire building is monolithic, being cast on the job complete.

These buildings are both heated with hot air delivered into the engine pits by means of underground conduits. Great care should be taken in selecting the heating coils and fan, as we have found that a plant that will heat a brick house with a timber roof is entirely too small for the same sized building, if made of concrete. The concrete house requires more ventilation than a brick house to avoid condensation on the inside of the walls and the under side of the roof in cold weather.

The slab construction is considerably cheaper than the monolithic construction in these roofs, but we do not feel that it is as good, although we have had no trouble with either of them. These buildings were completed in the spring of 1911.

At Gary, Indiana, we have a 20 stall brick roundhouse with concrete foundations, brick side walls and timber posts and with a slow burning roof construction, covered with prepared roofing. This building was completed in 1908. The dimensions of this house are the same as the reinforced concrete houses, each stall measuring 28 ft. 3 in. across the back, 15 ft. 6 in. across the front, and 85 ft. clear length inside. These buildings are all comparatively new, so we can give no comparison of costs of maintenance of the two types of construction.

We consider concrete a safer construction for engine houses than brick, as the timber or steel usually used in roofs of brick houses is liable to fail because of the steel rusting away or the timber construction burning.

We have no concrete shops completed to date. We have a locomotive shop under construction 150ft.x600ft., steel frame, concrete block walls and steel sash, but are not in a position to make a report on this at present.

A. O. Cunningham, chief engineer, Wabash R. R.:—The following gives a partial list of the material and shows the cost of a combination depot, 18ft.x 42ft. at Naples, Ill.:

MATERIAL.

Concrete.

Walls, piers, chimney and chimney slab, 35 cu. yds., requiring 158 sacks Portland cement, 14 cu. yds. sand and 28 cu. yds. of gravel.

Floors, 3 in. thick, 405.5 sq. ft., requiring 16 sacks Portland cement, 2 cu. yds. sand and 4 cu. yds. gravel.

Floor, 4 in. thick, 325.4 sq. ft., requiring 17 sacks Portland cement, 2 cu. yds. sand and 4 cu. yds. gravel.

Plastering.

Outside, 1½ in. thick, 97.5 sq. yds., requiring 43 sacks Portland cement, 4 cu. yds. sand, 1½ bbls. lime and 5 lbs. fiber.

Inside wall, 1 in. thick, walls, chimney and ceiling, 178.4 sq. yds., requiring 51 sacks Portland cement, 5 cu. yds. sand, 2 bbls. lime and 7 lbs. fiber.

Total material required for concrete wall, floors and plastering:

285 sacks Portland cement @ 42c.,	$ 119.70
27 cu. yds. sand @ 30c.,	8.10
36 cu. yds. gravel, @ 50c.,	18.00
4 bbls. lime, @ 70c.,	2.80
12 lbs. Excelsior cocoanut fiber, @ 5c.,	.60
298 sq. yds. trussit, 27 gage, @ 30c.,	89.40
8 steel corner beads, @60c.,	4.80
9 gal. Symentrix for outside plastering, @ $1.50,	13.50
	$ 256.90
Cinder fill, 221 cu. yds, @ 17c.,	37.57
Lumber, consisting of No. 1 yellow pine, 3,398 ft. B. M., @ $23.	78.15
1,750 ft. sheathing, @ $26,	45.50
500 ft. ceiling for eaves, @ $28,	14.00
Mill work, consisting of windows, doors, frames, counter, record case, telegraph table, etc.,	170.29
Hardware,	46.56
13¼ squares Cortright metal shingles, @ $4.25,	56.31
24 lin. ft. valleys, @ 10c.,	2.40
47 lin. ft. ridge, @ 12½ c.,	5.88
Painting and glazing,	31.85
Total, material,	$ 745.41

LABOR.

6 cu. yds. excavation, @ 25c.,	$ 1.50
230 cu. yds. grading fill and cinders for floor, at @10c.,	23.00
35 cu. yds. concrete foundation, @ $3,	105.00
405 sq. ft. floor, 3 in. thick, @ 5c.,	20.25
325 sq. ft. floor, 4 in. thick, @ 5¼c.,	17.06
Plastering, outside and inside,	104.42
Putting on 298 sq. yds. metal lath, @ 2½c.,	7.45
Carpenter work, framing 5.65 M. ft. B. M. lumber, @ $12.50,	70.63
Metal shingles, 13¼ sq. @ $1.50,	19.88
Painting and glazing,	55.65
Contingencies,	119.75
Total labor,	$ 544.59
Total labor and material,	1,290.00

PLATFORM.

Material.

32 cu. yds. cinders, @ 17c.,	$	5.44
965 sq. ft. concrete platform, 4 in. thick, requiring the following:		
50 sacks cement, @ 42c.,		21.00
6 cu. yds. sand, @ 30c.,		1.80
9 cu. yds. gravel @ 50c.,		4.50
	$	32.74

Labor.

Grading,	$	4.00
32 cu. yds. cinder foundation @ 10c.,		3.20
965 sq. ft. concrete platform @ 5½c.,		50.66
Contingencies,		9.40
	$	67.26
Total, labor and material,		100.00

DISCUSSION.

The President:—Gentlemen, we would like to hear from the members regarding their experiences with reference to the subject in hand. The report seems to be quite complete, but there may be some points which are not brought out.

Mr. J. S. Robinson:—I think that brick is unquestionably as good as concrete in all climates and generally better for buildings, and I think also that it is far better for platforms, as well. If laid in large slabs, concrete floors become irregular, and crack, while brick can be laid economically on a sand cushion, holds its surface well, and will last a great many years. I think it is cheaper and better wearing, as a rule, than concrete and costs considerably less, when laid flat. On the way here from Chicago, I noticed a great many platforms where the brick are laid on edge. On the Northwestern system we discontinued that method some years ago and find that we can lay brick platforms, where the brick are laid flat, for seven or seven and one-half cents a square foot.

Mr. Pickering:—I would like to ask Mr. Robinson if he has any difficulty with the brick breaking under heavy trucks? Up in our country we use trucks that are frequently loaded with from one to two tons of baggage and we have a good deal of difficulty in maintaining a platform of that character, or a concrete platform that will not crack under such loads.

Mr. Robinson:—We have never had any brick break under traffic. We have had them crack by throwing heavy loads, such as freight and large pieces of baggage on them, where the metal came in contact with the platform and cracked the vitrified surface; then they deteriorate very rapidly. We lay the brick with close joints and fill the intervening spaces with sand. When a brick is broken we can remove it easily with a hook and replace it at a small cost. We use 12 in. of cinders and two in. of sand as a cushion for the foundation.

Mr. Long:—I notice in the report the illustration of the Gary, Ind., station and I want to give you our experience of the life of the concrete in those walls. Concrete, like brick, requires furring on the inside, in order to keep it from sweating. We had recommended to us a waterproofing paint which we used on the interior instead of the furring strips, as it was cheaper. Unfortunately, this waterproofing was a failure and the outside walls of this station are peeling badly, so that we contemplate removing it with wire brushes and trying to find something that will take its place and make the walls waterproof. The proper method of waterproofing concrete, in my opinion, has not been definitely settled. There are a number of products which are mixed with concrete which are claimed to give good results. We have not tried them as yet, but what we have applied to the outside of buildings have not been altogether successful.

The Secretary:—Since Mr. Long is an architect, I would like to ask how he regards concrete as compared with brick for a structure of that kind, generally speaking?

Mr. Long:—Generally speaking, if I could make it watertight, it would give much better results, in some types of architecture than brick would. It cost us no more for this building than brick would have cost. We designed it in the classical style of architecture and made of it an all-concrete building, because we got the cement at Buffington, near by. We did it principally at the suggestion of the United States Steel Co., who wanted to have an all-concrete building, made entirely of steel and Portland cement, as a show-card for their material. In designing this, we kept in mind the fact that this was taking the place of stone. If I had designed the building for a stone building, I would have used the same construction I used here, but had it been designed for a brick building, I would have built it a great deal different and used a different construction. Concrete, as a general rule,

costs more than brick, because, as the contractor said when we started building this structure, the forms he had to make—he called them the "fifty-seven varieties"—created considerable expense for that item.

Mr. J. H. Markley:—We have not, as yet, used any concrete in the construction of our passenger or freight stations, but we have two stations that cost $10,000 each, one that cost $6,000, one that cost $2,600, and one that cost $3,000, of brick veneer. We do not contemplate building anything else in the future, for stations costing about $2,000. We built the station, a cut of which is shown in the Railway Age Gazette of May 17 last, for $2,800.

To illustrate the practicability and the feasibility of this character of structure, which is better than wood, we had a joint station built on the road of practically the same size with a metal roof put on it that cost $2,500 and was not nearly as good a looking building. Another thing that ran the price up on this building was the concrete foundation. We got into a soft place and had to increase our footings considerably over what they would have been if we had got into an ordinary clay soil. The building is well built throughout with a slate roof, galvanized iron gutters, and concrete floor in the waiting rooms. It was finished inside above the wainscoting with beaver board instead of beaded ceiling or plastering and I believe it is the first station building of its kind that is finished in that way. The finish is very nice and I consider it a very beautiful little station.

Mr. Decker:—We have not built any concrete buildings but use brick altogether on a concrete foundation in our modern stations, and the same construction in our freight and engine houses. We use brick in our platforms. We had several rather important stations, where the brick were laid on edge some years ago. During the last year or so we have taken them up and relaid them flat on a sand cushion without grouting, and so far they have stood up very well. We have not had any trouble with brick breaking except, as Mr. Robinson said, in unloading heavy baggage, if it is dropped on the brick, it will occasionally break a brick.

Mr. Robinson:—I wish to say that we have just covered up some concrete platforms that were laid in 1887 and which have always given us more or less trouble; they cracked in every conceivable way and we had to repair them to keep them in use. Every few years we had to go over them, level them up as best

we could, put a surface over them and plaster them. They were unsightly and were not a success. Where we have raised our tracks in ballasting we have covered them up instead of taking them up and used them simply as foundations for the brick platforms.

Mr. Killam:—All of our freight houses have concrete walls under the office end and concrete columns ten or twelve ft. apart under the freight end. The station houses and all the roundhouses are built on concrete foundations up to the base of the building. We build the station houses of brick. We have no concrete buildings, as brick is more artistic and looks better. We are building a station house just now at Huron and have just finished a freight house that has a concrete foundation and platform. At all the principal stations we have been laying concrete platforms for a number of years and they have given good satisfaction. Of course now and then there is a crack due to the foundation not being properly put in by the contractor, but taking them all together, the concrete platforms are giving excellent satisfaction, and are considered the cheapest and best platforms that we have. Some have been in use ten or eleven years.

Mr. Pickering:—Are they made of cement or entirely ot concrete?

Mr. Killam:—They are made of Portland cement and a fine quality of sand with a small portion of stone. Where small failures have occurred the top or finishing coat was not put on quick enough and a block or square has had to be repaired in one or two cases.

Mr. Pickering:—I am deeply interested in this platform question and I would like to ask Mr. Killam first in regard to the foundation for those concrete platforms, and second the approximate cost?

Mr. Killam:—I can not give you the exact cost. The foundation is thoroughly under-drained and dry earth is put down with cinders on that and then a coat of sand, with the concrete on top of that.

Mr. Pickering:—How deep is your base?

Mr. Killam:—We put down two or three feet of dry filling including cinders.

Mr. W. O. Eggleston:—I notice that our line has put down some concrete platforms 30 to 60 ft. long in the last year and a half, without any expansion joints. The platforms are from 10

ft. to 14 ft. wide. Two such platforms that I have seen within the last week, where I know they have been done for a year, show no cracks in them yet. I was told by the parties who did the work, that they put in about two feet of engine cinders, thoroughly rammed and very wet, and placed the concrete mixture on that—I think they said it was about seven inches thick I understood that the concrete was mixed with a continuous mixer, was floated down into a solid, complete mass, and was surfaced with what might be called a scraper which left it in a slightly rough condition,—not polished up at all. The work is good and it has simply been a question with me whether it will stand without cracking. It is under heavy trucking, and a great many people pass over it. We all know that sections four, five or six ft. square, get out of surface and then trouble commences. One cannot patch a concrete platform and make a success of it.

Mr. Killam:—There is just one thing I forgot. Our platforms are put down in three or four ft. squares, separated so they are all disconnected with a finished space of one-half inch between each block, so that cracks don't extend from one to the other.

Mr. Musgrave:—I have had considerable experience in laying concrete platforms and sidewalks, with almost perfect success. I lay a bed of engine cinders from a foot to 16 in. thick, wetting them down well and ramming them to get them solid, then lay concrete five in. thick in blocks in alternate sections and about five or six ft. square. I let them set, take the forms off and use these blocks as forms to lay the other concrete in. I don't believe that a thick topcoat does the concrete any good, providing the topcoat is placed at the same time the bottom is, making an absolute monolith. I have laid 2,200 ft. in one instance, at a cost of 11½ cts. per sq. ft. The sand costs $1 per cu. yd., the gravel $1 and the cement about 40 cts. per sack. That platform has been in now about four years; it has shown absolutely no settling and I don't think there is a crack anywhere in it. They run heavy baggage trucks over that and drop machinery, draw-heads, etc., on it.

Mr. Killam:—We run a little notched roller over the top which makes it rough enough so that there are no complaints of slipping. The last work cost some 19 cts. per sq. ft., which was considered too high, and what was done this year cost 14¾ cts. per sq. ft.

Mr. Eggleston:—One should not rough up concrete with any

kind of a tool after it has had its initial set, for if he does he will destroy part of its durability. You will notice sidewalks that have been smoothed down with a trowel, and which are full of hair cracks that I believe are caused by disturbing it after the initial set.

Mr. Robinson:—Our experience is that the more one trowels a sidewalk, the better he gets it, the same as a floor. If one don't trowel it thoroughly, he don't get a good wearing surface. Our sidewalks have a mixture of four inches of 1 : 3 : 6, concrete, with a top coating of one inch of 1 : 2 mortar (one part cement and two parts of washed torpedo sand). There is a difference between sidewalks and station platforms. We have built, in the city of Peoria, within the last two months, three-quarters of a mile of sidewalk five feet wide, for ten cents a square foot, but we would not use such construction for a railroad platform. I claim that the construction must be heavier, as the conditions of service on railroad platforms are entirely different from those of a sidewalk. A sidewalk is narrow and well drained, while a depot platform is not, unless artificial drainage is provided. The prices I have heard here are much higher than our brick platforms cost and one cannot repair a cement platform as cheaply as he can a brick platform and make a good job of it. I would like to ask Mr. Eggleston what his seven inch platform cost?

Mr. Eggleston:—I cannot answer the question, as I was not connected with that division except as inspector. About 20 years ago we put in three brick platforms at very busy stations. All three of them were located in county seats. One has about five ft. of engine ashes under it, where there was a big hole under an old wooden platform, and one other had about a foot of filling. We thoroughly rolled and rammed this and then we put on a one-inch coating of sand. We then laid a hard common brick on edge, about seven brick to the square foot, and I am not ashamed to look at any of those three platforms today. They are in almost perfect condition under very severe usage. They were not of vitrified brick, but only good, hard burned common brick that we paid eight dollars a thousand for.

Mr. Robinson:—We had a concrete platform at one of our important stations, where we had to change the grade of the platform on account of ballasting. We were unable to raise that platform and get a surface of any kind. The slabs were so uneven that women especially were liable to trip on them. We dis-

carded that platform and replaced it with brick. The brick platforms we were able to raise at a very low cost, and when the work was done the surface was just as good as before.

The Secretary:—Over ten years ago, when I was acting in the capacity of superintendent of bridges and buildings of the Chicago & Northwestern, at Fond du Lac, Wis., I had charge of the construction of quite a large platform at that place (approximately 12 ft. x 200 ft.) the material of which we termed "cinder concrete." It was composed of cinders, sand and cement. It was given a rough finish on top, but as it wore down the effect of the cinders kept it from becoming smooth, and it never became slippery, unless coated with ice, and in that event any kind of a surface will be slippery. This platform is located between two main tracks, at a junction point, and is used a great deal in transferring baggage, mail, express and passengers and the platform is still in service. This was made in one continuous piece and it never checked to amount to anything. I know of other platforms built of concrete which have been very satisfactory, some of them as far north as the line of the Northern Pacific. While they seem to be satisfactory as far north as that, they would give still better service farther south, where the winters are not so severe.

Where a platform will not be disturbed during its lifetime, I think that concrete will give better service than brick; but if the foundation is liable to settle the one constructed of brick can be put into surface and repaired far more satisfactorily than one built of concrete.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891.	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892.	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Col.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis...	H. M. Hall......	J. E. Wallace....	Geo. W. Andrews.
1st. V.-Pres. .	H. M. Hall....:	J. E. Wallace....	Geo. W. Andrews..	W. A. McGonagle.
2nd. V.-Pres.	J. B. Mitchell..	G. W. Hinman..	W. A. McGonagle.	L. K. Spafford.
3rd. V.-Pres.	James Stannard.	N. W. Thompsor	L. K. Spafford....	James Stannard.
4th. V.-Pres. .	G. W. Hinman..	C. E. Fuller....	E. D. Hines......	Walter G. Berg.
Secretary, ...	C. W. Gooch...	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid.	George M. Reid..	George M. Reid..	George M. Reid.
Executive Members .	W. R. Damon..	G. W. Andrews..	Q. McNab	James Stannard.
	G. W. Markley.	J. M. Staten....	A. S. Markley....	James H. Travis.
	W. A. McGonagle	J. M. Caldwell..	Floyd Ingram.....	J. H. Cummin.
	G. W. McGehee.	Q. McNab.......	James Stannard ..	R. M. Peck.
	G. W. Turner...	Floyd Ingram...	James H. Travis ..	J. L. White.
	J. E. Wallace...	A. S. Markley..	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President	W. A. McGonagle	James Stannard.	Walter G. Berg....	J. H. Cummin.
1st. V.-Pres. .	L. K. Spafford.	Walter G. Berg.	J. H. Cummin....	A. S. Markley.
2nd. V.-Pres.	James Stannard.	J. H. Cummin...	A. S. Markley....	C. C. Mallard.
3rd. V.-Pres.	Walter G. Berg.	A. S. Markley..	G. W. Hinman....	W. A. Rogers.
4th. V.-Pres. .	J. H. Cummin.	R. M. Peck....	C. C. Mallard.....	J. M. Staten.
Secretary	S. F. Patterson.	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid.	N. W. Thompsor	N. W. Thompson..	N. W. Thompson.
Executive Members .	R. M. Peck....	W. O. Eggleston	G. J. Bishop......	Wm. S. Danes.
	J. L. White...	W. M. Noon....	C. P. Austin......	J. H. Markley.
	A. Shane	J. M. Staten....	M. Riney	W. O. Eggleston.
	A. S. Markley..	G. J. Bishop.....	Wm. S. Danes....	R. L. Heflin.
	W. M. Noon...	C. P. Austin....	J. H. Markley....	F. W. Tanner.
	J. M. Staten...	M. Riney	W. O. Eggleston..	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President	Aaron S. Markley	W. A. Rogers...	W. S. Danes.....	B. F. Pickering.
1st. V.-Pres. .	W. A. Rogers...	W. S. Danes....	B. F. Pickering..	C. C. Mallard.
2nd. V.-Pres.	J. M. Staten....	B. F. Pickering.	A. Shane	A. Shane.
3rd. V.-Pres.	Wm. S. Danes...	A. Shane.......	A. Zimmerman ..	A. Zimmerman.
4th. V.-Pres. .	B. F. Pickering..	A. Zimmerman .	C. C. Mallard....	A. Montzheimer.
Secretary	S. F. Patterson..	S. F. Patterson.	S. F. Patterson..	S. F. Patterson.
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson.	N. W. Thompson.
Executive Members .	T. M. Strain....	T. M. Strain....	A. Montzheimer..	W. E. Smith.
	R. L. Heflin....	H. D. Cleaveland.	W. E. Smith.....	A. W. Merrick.
	F. W. Tanner...	F. W. Tanner..	A. W. Merrick...	C. P. Austin.
	A. Zimmerman...	A. Montzheimer.	C. P. Austin.....	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith....	C. A. Lichty.....	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick..	W. O. Eggleston.	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President	A. Montzheimer..	C. A. Lichty...	J. B. Sheldon....	J. H. Markley.
1st. V.-Pres. .	A. Shane	J. B. Sheldon..	J. H. Markley....	R. H. Reid.
2nd. V.-Pres.	C. A. Lichty....	J. H. Markley..	R. H. Reid.......	J. P. Canty.
3rd. V.-Pres.	J. B. Sheldon...	R. H. Reid.....	R. C. Sattley....	H. Rettinghouse.
4th. V.-Pres. .	J. H. Markley...	R. C. Sattley...	J. P. Canty......	F. E. Schall.
Secretary	S. F. Patterson..	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.
Treasurer	C. P. Austin....	C. P. Austin....	C. P. Austin.....	C. P. Austin.
Executive Members .	R. H. Reid......	W. O. Eggleston	H. Rettinghouse .	W. O. Eggleston.
	W. O. Eggleston	A. E. Killam....	A. E. Killam.....	A. E. Killam.
	A. E. Killam....	H. Rettinghouse.	J. S. Lemond.....	J. S. Lemond.
	R. C. Sattley....	J. S. Lemond....	C. W. Richey....	C. W. Richey.
	H. Rettinghouse..	W. H. Finley..	H. H. Eggleston.	H. H. Eggleston.
	J. S. Lemond....	C. W. Richey...	F. E. Schall.....	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid......	J. P. Canty	J. S. Lemond...	H. Rettinghouse
1st. V.-Pres. .	J. P. Canty.....	H. Rettinghouse..	H. Rettinghouse..	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse..	F. E. Schall.....	F. E. Schall.....	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond....	A. E. Killam...	J. N. Penwell
4th. V.-Pres. .	W. O. Eggleston.	A. E. Killam....	J. N. Penwell..	L. D. Hadwen .
Secretary	S. F. Patterson..	S. F. Patterson..	C. A. Lichty....	C. A. Lichty
Treasurer	C. P. Austin....	C. P. Austin....	J. P. Canty....	J. P. Canty
Executive Members .	A. E. Killam....	J. N. Penwell....	W. Beahan	T. J. Fullem
	J. S Lemond.....	Willard Beahan ..	F. B. Scheetz .	G. Aldrich
	C. W. Richey....	F. B. Scheetz...	L. D. Hadwen ..	P. Swenson
	T. S. Leake......	W. H. Finley...	T. J. Fullem....	G. W. Rear
	W. H. Finley....	L. D. Hadwen ..	G. Aldrich......	W. O. Eggleston.
	J. N. Penwell....	T. J. Fullem....	P. Swenson.....	W. F. Steffens

	1911-1912.	1912-1913.		
President	F. E. Schall	A. E. Killam....		
1st. V.-Pres. .	A. E. Killam ...	J. N. Penwell...		
2nd. V.-Pres.	J. N. Penwell ...	L. D. Hadwen...		
3rd. V.-Pres.	L. D. Hadwen ..	T. J. Fullem....		
4th. V.-Pres. .	T. J. Fullem	G. Aldrich		
Secretary	C. A. Lichty	C. A. Lichty.....		
Treasurer	J. P. Canty	J. P. Canty......		
Executive Members .	G. Aldrich	G. W. Rear....		
	P. Swenson	W. F. Steffens...		
	G. W. Rear	E. B. Ashby....		
	W. F. Steffens ..	C. E. Smith....		
	E. B. Ashby	S. C. Tanner....		
	W. O. Eggleston	Lee Jutton		

CONSTITUTION

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the principles, design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussion of the experience of its members and others, and to provide a means of exchange of ideas, so that bridge and building practice may be systematized and improved.

SECT. 2. The association shall neither endorse nor recommend any particular patents, materials or supplies, but individual opinions of members may be expressed and appear in the proceedings.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall consist of two classes, active and life members.

SECT. 2. A person who is actively engaged in railway service in a responsible position, in charge of work connected with the construction or maintenance of railway bridges and buildings or other structures, or a professor of engineering, government timber expert, or railroad architect shall be eligible for active membership upon application to the secretary, and the payment of three dollars membership fee, and two dollars for one year's dues.

SECT. 3. Any member elected a life member of this association shall have all the privileges of an active member, but shall not be required to pay annual dues. To be elected a life member he must have been a member of the association at least five years and before being elected must have been pensioned by the railway company for which he worked or shall have retired from active railway service.

SECT. 4. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this association, or who shall refuse to obey the chairman, or rules, may be expelled by a two-thirds vote of the members present.

SECT. 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members.

SECT. 2. The executive members, together with the president, vice-presidents, secretary and treasurer, shall constitute the executive committee.

SECT. 3. Past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past-presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECT. 4. Vacancies in any office for the unexpired term shall be filled by the executive committee without unnecessary delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECT. 2. Two thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECT. 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the association, held on the third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

SECT. 2. The president and treasurer shall be elected by ballot by a majority of votes cast, and shall hold office for one year or until successors are elected. No member in arrears shall be eligible for office, and the president shall not be eligible for re-election.

Vice-Presidents and Executive Members.

SECT. 3. The vice-presidents shall hold office for one year and executive members for two years; four vice-presidents and three executive members to be elected each year; all officers herein named to hold office until successors are chosen.

SECT. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members shall be elected in the same way, all voting to be by written ballots.

Secretary.

SECT. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the executive committee, two thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the executive committee. The secretary shall also be secretary of the executive committee.

Treasurer.

SECT. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

COMMITTEES.

Nominating Committee.

SECTION 1. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year. They shall prepare a list of names of nominees for officers to be voted on at the next annual convention, agreeable to Article VI. of this constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making nominations.

Auditing Committee.

SECT. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and treasurer and certify as to the correctness of their accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

Committee on Subjects for Discussion.

SECT. 3. At the annual meeting there shall be appointed, by the president, a committee, whose duty it shall be to prepare and report subjects for investigation and discussion at the next annual meeting. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall decide whether such questions are suitable ones for discussion, and if approved, report them to the association.

Committees on Investigation.

SECT. 4. When the committee on subjects has reported and the association approved of the same, the president shall appoint special committees to investigate and report on said subjects, and he may appoint a special committee to investigate and report on any subject of which a majority of members present may approve.

Publication Committee.

SECT. 5. After each annual meeting the executive committee shall appoint a publication committee of three active members whose duty it shall be to supervise the publication of the proceedings. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year. The publication committee will report to the president and perform their duties under his supervision.

ARTICLE VIII.

ANNUAL DUES.

SECTION 1. Every active member shall pay to the secretary three dollars membership fee and shall also pay two dollars per year in advance to defray the necessary expenses of the association. No member being one year in arrears for dues shall be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE IX.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two thirds vote of members present, provided that a written notice of the proposed amendment, or amendments, has been given at least sixty days previous to said regular meeting.

BY-LAWS

TIME OF MEETING.

1. The regular meeting of this association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m., unless changed by order of the presiding officer.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
   2nd—Reading minutes of last meeting.
   3rd—Admission of new members.
   4th—President's address.
   5th—Reports of secretary and treasurer.
   6th—Payment of annual dues.
   7th—Appointment of committees.
   8th—Reports of committees.
   9th—Unfinished business.
   10th—New business.
   11th—Reading and discussion of questions propounded by members.
   12th—Miscellaneous business.
   13th—Election of officers.
   14th—Adjournment.

(Report of nominating committee to be read at first session of second day.)

DUTIES OF OFFICERS.

6. The president shall have general supervision of the affairs of the association. He shall preside at all meetings of the asso-

ciation, and of the executive committee, at which he may be present; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with the secretary, sign all contracts or other written obligations of the association which have been approved by the executive committee.

At the annual meeting the president shall present a report containing a statement of the general condition of the association, and an address.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president, and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; collect all moneys due the association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the association may require.

9. The treasurer shall receive all moneys and deposit the same in the name of the association and shall receipt to the secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Robert's rules of order.

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Walther, C. H., Supvr. B. & B., Mo. Pac. Ry., Poplar Bluff, Mo.
Warcup, C. F., For. W. S., G. T. R., St. Thomas, Ont.
Ware, B. C., Mast. Carp., C. R. I. & P. Ry., Dalhart, Tex.
Ware, Norton, C. E., Forum Bldg., Sacramento, Cal.
Warne, C. C., Purch. Dept., N. Y. C. & H. R. R., New York City.
Watson, P. N., Supvr. B. and B., Maine Central R. R., Brunswick, Me.
Wehlen, Charles, Br. Inspr., L. I. R. R., Jamaica, N. Y.
Weise, F. E., Chief Clerk, Eng. Dept., C. M. & St. P. Ry., Chicago.
Weldon, A., For. B. & B., Sou. Pac. Co., Los Angeles, Cal.

Welker, G. W., Supvr. B. and B., Southern Ry., Alexandria, Va.
Wells, A. A., R. M. and Supvr. B. & B., Sou. Ry., Winston-Salem, N. C.
Wells, D. T., For. B. and B., O. S. L. R. R., Salt Lake City, Utah.
Wells, J. M., A. T. & S. F. Ry., Chillicothe, Ill.
Wenner, E. R., Supvr. B. and B., L. V. R. R., Ashley, Pa.
Wheaton, L. H., Div. Engr., G. T. P. Ry., Dartmouth, N. S.
White, I. F., Div. Engr., C. H. & D. Ry., Dayton, O.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
Whiting, B. F., Supvr. B. & B., M. & O. R. R., Murphysboro, Ill.
Whitney, W. C., Supvr. B and B., B. & A. R. R., Boston, Mass.
Wicks, Warren, Gen'l For. L. I. R. R., Amityville, N. Y.
Wiley, J. G., Supvr. B. and B., Sou. Pac. Co., Dunsmuir, Cal.
Wilkinson, J. M., For. B. and B., C. N. R. R., Van Wert, Ohio.
Wilkinson, W. H., Bridge Insp., Erie R. R., Elmira, N. Y.
Williams, Arthur, Engr., W. & M. Ry., Wellington, N. Z.
Williams, J. C., Supvr. B. and B., A. & W. P. Ry., Opelika, Ala.
Williams, M. R., Gen. For. B. & B., A. T. & S. F. Ry., Las Vegas, N. M.
Wilson, E. E., Supvr. of Bridges, N. Y. C. & H. R. R. R., New York City, (81 E. 125th St.).
Wilson, Jas. A., Contract Foreman, Woodbine, Ga.
Wilson, M. M. Div. Br. Inspr., Sou. Pac. Co., Los Angeles.
Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Witt, C. C., Engr. Kans. Pub. Utilities Com., Topeka, Kans.
Wolf, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Wood, J. P., For. B. & B., P. M. R. R., Edmore, Mich.
Wood, J. W., Gen'l For. B. and B., A. T. & S. F. Ry., Needles, Cal.
Wood, W. E., Dist. Engr., C. M. & St. P. Ry., Chicago.
Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Ill. Traction System, Decatur, Ill.

Yappen, Adolph, Dist. Carp., C. M. & St. P. Ry., Chicago.
Yereance, W. B., Cons. Engr., 128 Broadway, New York City.
Young, R. C., Chief Engr., L. S. & I. Ry., Marquette, Mich.

Zinck, K. J. C., Ch. Engr., Alberta Int. Ry., Calgary, Alta.
Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Zanesville, O.
Zook, D. C., Mast. Carp., Pa. Lines W. of Pitts., Ft. Wayne, Ind.

LIFE MEMBERS.

Austin, C. P., 107 Park St., Medford, Mass.
Carmichael, Wm., St. J. & G. I. R. R., St. Joseph, Mo.
Carpenter, J. T., Sou. Ry., Princeton, Ind.
Cummin, Jos. H., Bay Shore, N. Y.
Findley, A., 929 Wash. Ave., Portland, Me.
Forbes, Jno., 45 Victoria Road, Halifax, N. S.
Foreman, John, P. & R. Ry., Pottstown, Pa.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
Hubbard, A. B., B. & M. R. R., Boston, Mass.
Lydston, W. A., B. & M. R. R., Salem, Mass.
McIntyre, James, Miami, Fla.
McLean, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Noon W. M., Palatka, Fla.
Patterson, S. F., B. & M. R. R., Concord, N. H.
Porter, L. H., Box 35, Andover, Conn.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Travis, O. J., Box 11, Lowell, Wash.
Vandegrift, C. W., C. & O. Ry., Ronceverte, W. Va.
Wells, J. M., Chillicothe, Ill.
Wise, E. F., 207 Clay St., Waterloo, Ia.

DECEASED MEMBERS.

Amos, A.,
Berg, Walter G.
Bishop, Geo. J.
Blair, J. A.
Brady, James.
Carr, Charles.
Causey, T. A.
Cleaveland, H. D.
Costolo, J. A.
Crane, Henry
DeMars, James.
Dunlap, H.
Fletcher, H. W.
Fuller, C. E.
Gilbert, J. D.
Gilchrist, E. M.
Graham, T. B.
Hall, H. M.
Heflin, R. L.
Henson, H. M.
Hinman, G. W.
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lantry, J. F.
Large, C. M.
Larson, G.
Lovett, J. W.
Markley, Abel S.
McCormack, J. W.
McGehee, G. W.
Mellor, W. J.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, T. H.
Morrill, H. P.
Peck, R. M.
Perry, W. W.
Phillips, W. H.
Powell, W. T.
Reid, G. M.
Renton, Wm.
Reynolds, E. F.
Robertson, Daniel
Schwartz, J. C.
Spafford, L. K.
Spangler, J. A.
Spaulding, E. C.
Spencer, C. F.
Taylor, J. W.
Thompson, N. W.
Tozzer, Wm. S.
Trautman, T. J.
Van Der Hoek, J.
Wallace, T. E.
Walden, W. D.
Welch, E. T.
Wood, W. B.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Alberta Interurban Ry.,	2	10
V. A. Newhall, Calgary, Alta.		
K. J. C. Zinck, Calgary, Alta.		
Algoma Central & Hudson Bay Ry.	1	116
R. S. McCormick, Sault Ste. Marie, Ont.		
Arizona Eastern R. R.	1	355
C. C. Mallard, Globe, Ariz.		
Atchison, Topeka & Santa Fé Ry	5	5,848
A. J. James, Topeka, Kans.		
E. McCann, Wellington, Kan.		
John L. Talbott, Pueblo, Col.		
J. M. Wells, Chillicothe, Ill.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	5	2,022
E. E. Ball, Winslow, Ariz.		
J. F. Parker, San Bernardino, Cal.		
V. C. Proctor, Winslow, Ariz.		
D. A. Shope, Fresno, Cal.		
J. W. Wood, Needles, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	2	225
O. T. Nelson, Montgomery, Ala.		
J. C. Williams, Opelika, Ala.		
Atlantic Coast Line R. R.	1	4,500
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. and B. & O. S. W. R. R.	21	4,738
G. W. Andrews, Baltimore, Md.		
S. H. Blowers, Columbus, O.		
W S. Bouton, Baltimore, Md.		
Z. T. Brantner, Martinsburg, W. Va.		
H. R. Bricker, Baltimore, Md.		
W. M. Clark, Pittsburgh, Pa.		
W. R. Edwards, Baltimore, Md.		
W. T. Hopke, Grafton, W. Va.		
E. G. Lane, Baltimore, Md.		
M. A. Long, Baltimore, Md.		
B. S. Mace, Baltimore, Md.		
J. T. McIlwain, Akron, O.		
E. G. Moore, Grafton, W. Va.		
J. O. Potts, Baltimore, Md.		
W. S. Schenck, Connellsville, Pa.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		

Name of Road and Membership.	Members.	Mileage
Baltimore & Ohio R. R. and B. & O. S. W. R. R.	Continued.	
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
T. E. Thomas, Wilmington, Del.		
E. C. Zinsmeister, Zanesville, O.		
Baltimore & Ohio, Chicago Terminal R. R.	1	289
H. H. Eggleston, Chicago.		
Bangor & Aroostook R. R.	2	628
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
Boston & Albany R. R.	2	392
W. F. Steffens, Boston, Mass.		
W. C. Whitney, Boston, Mass.		
Boston & Maine R. R.	14	2,288
Cyrus P. Austin, Medford, Mass.		
C. C. Battey, Concord, N. H.		
J. P. Canty, Fitchburg, Mass.		
John Ewart, Boston, Mass.		
Andrew B. Hubbard, Boston, Mass.		
F. J. Leavitt, Salem, Mass.		
William A. Lydston, Salem, Mass.		
John Marsh, Lawrence, Mass.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Concord, N. H.		
S. F. Patterson, Concord, N. H.		
B. F. Pickering, Salem, Mass.		
Fred C. Rand, Boston, Mass.		
F. A. Sherwin, St. Johnsbury, Vt.		
Brazil Ry.	1	10,000
A. M. Dodd, Sao Paulo, Brazil, S. A.		
Canadian Pacific Ry.	3	10,832
F. P. Gutelius, Montreal, P. Q.		
Frank Lee, Winnipeg, Man.		
D. A. McRae, Cranbrook, B. C.		
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Jr., Chester, S. C.		
Central of Georgia Ry.	1	1,916
H. C. McKee, Macon, Ga.		
Central Vermont Ry.	3	536
C. Donaldson, Waterbury, Vt.		
C. F. Flint, St. Albans, Vt.		
H. E. Holmes, New London, Conn.		
Chesapeake & Ohio Ry.	5	2,027
F. M. Griffith, Covington, Ky.		
Oscar L. Grover, Richmond, Va.		
C. E. Powell, Hinton, W. Va.		
J. M. Staten, Richmond, Va.		
C. W. Vandegrift, Ronceverte, W. Va.		

Name of Road and Membership.	Members.	Mileage
Chicago & Alton R. R.	1	1,025
C. A. Stelle, Bloomington, Ill.		
Chicago & Eastern Illinois R. R.	1	1,266
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.	29	8,101
L. J. Anderson, Escanaba, Mich.		
H. Bender, Eagle Grove, Ia.		
W. A. Brewer, Clyman, Wis.		
F. L. Burrell, Fremont, Neb.		
F. M. Case, Belle Plaine, Ia.		
O. F. Dalstrom, Chicago.		
H. H. Decker, Chicago, Ill.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
G. W. Hand, Chicago, Ill.		
John Hunciker, Chicago, Ill.		
Lee Jutton, Chicago, Ill		
C. F. King, Omaha, Neb.		
C. A. Lichty, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
W. T. Main, Chicago, Ill.		
C. A. Marcy, Chicago, Ill.		
W. F. Meyers, Belle Plaine, Ia.		
J. D. Moen, Boone, Ia.		
J. A. S. Redfield, Fond du Lac, Wis.		
H. Rettinghouse, Mason City, Ia.		
R. W. Richardson, Sioux City, Ia.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville, Antigo, Wis.		
Wm. Spencer, Chadron, Nebr.		
W. M. Sweeney, Green Bay, Wis.		
J. B. White, Boone, Ia.		
Chicago, Burlington & Quincy R. R.	4	9,075
W. E. Elder, Burlington, Ia.		
Geo. Fenney, McCook, Neb.		
W. Hurst, St. Joseph, Mo.		
C. J. Scribner, Chicago.		
Chicago Great Western R. R.	2	1,492
W. L. Derr, Clarion, Ia.		
H. A. Elwell, Clarion, Ia.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.	15	9,585
(and C. M. & P. S. Ry.)		
E. J. Auge, Wells, Minn.		
A. G. Bennett, Minneapolis, Minn.		
E. E. Clothier, Perry, Ia.		
H. R. Drum, Chamberlain, S. D.		
L. D. Hadwen, Chicago, Ill.		
F. E. King, Minneapolis, Minn.		
N. H. LaFountain, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage
Chicago, Milwaukee & St. Paul Ry. Continued.		
C. F. Loweth, Chicago, Ill.		
E. S. Meloy, Chicago.		
Edw. Murray, Miles City, Mont.		
William Ross, Milbank, S. D.		
Fred E. Weise, Chicago, Ill.		
William E. Wood, Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
A. Yappen, Chicago, Ill.		
Chicago, Rock Island & Pacific Ry.	8	7,551
McClellan Bishop, El Reno, Okla.		
C. H. Eggers, Little Rock, Ark.		
E. R. Floren, Rock Island, Ill.		
Guy Gordon, Little Rock, Ark.		
M. E. Gumphrey, Eldon, Mo.		
W. V. Parker, Amarillo, Tex.		
R. C. Sattley. Chicago.		
R. Wagner, Little Rock, Ark.		
Chicago, St. Paul, Minneapolis & Omaha Ry.	2	1,744
A. G. Rask, Spooner, Wis.		
Aug. Ruge, Mankato, Minn.		
Chicago, Terre Haute & Southern Ry.	2	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, Hamilton & Dayton Ry.	1	1,015
I. F. White, Dayton, O.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry.	4	1,250
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
Colorado Midland Ry.	1	338
J. Guretzky, Colorado City, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Concho, San Saba & Llano Valley R. R.	1	61
K. S. Hull, Temple, Tex.		
Copper Range R. R.	1	150
A. Giesing, Houghton, Mich.		
Delaware, Lackawanna & Western R. R.,	7	985
F. J. Arnold, Scranton, Pa.		
G. E. Boyd, Scranton, Pa.		
E. Cahill, Binghamton, N. Y.		
C. G. Connolly, Scranton, N. Y.		
A. McQueen, Binghamton, N. Y.		
J. E. Ranney, Buffalo, N. Y.		
Jas. Skeoch, Dunmore, Pa.		

Name of Road and Membership.	Members.	Mileage
Denver & Rio Grande R. R.	6	2,598
G. W. Kinney, Salt Lake City.		
A. Ridgway, Denver, Colo.		
A. C. Snyder, Salt Lake City.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
Jas. Vaughan, Salida, Colo.		
Duluth & Iron Range R. R.	2	168
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.	1	297
W. A. McGonagle, Duluth, Minn.		
Elgin, Joliet & Eastern Ry.	3	770
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
C. Thompson, Joliet, Ill.		
Erie R. R. (and Chicago & Erie)	7	2,665
O. F. Barnes, Susquehanna, Pa.		
W. O. Eggleston, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		
F. A. Knapp, Jersey City, N. J.		
W. H. Matthews, Hornell, N. Y.		
Neil McLean, Huntington, Ind.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	2	708
E. K. Barrett, St. Augustine, Fla.		
A. M. Van Auken, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Georgia & Florida Ry.	1	325
W. A. Swallow, Augusta, Ga.		
Grand Rapids & Indiana Ry.	2	592
W. S. McKeel, Grand Rapids, Mich.		
H. M. Large, Ft. Wayne, Ind.		
Grand Trunk Ry. System	6	4,756
J. B. Gaut, Montreal, Que.		
J. Henderson, St. Thomas, Ont.		
George A. Mitchell, Toronto, Ont.		
H. C. Swartz, St. Thomas, Ont.		
J. E. Travis, Toronto, Ont.		
C. F. Warcup, St. Thomas, Ont.		
Grand Trunk Pacific Ry.	1	2,440
L. H. Wheaton, Dartmouth, N. S.		
Gulf, Colorado and Santa Fé Ry.	4	1,603
E. C. George, Beaumont, Tex.		
K. S. Hull, Temple, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		

Name of Road and Membership.	Members.	Mileage
Hampshire Southern R. R.	1	38
W. Trapnell, Romney, W. Va.		
Illinois Central R. R.	11	4,755
P. Aagaard, Chicago, Ill.		
F. O. Draper, Chicago, Ill.		
C. Ettinger, Chicago.		
T. J. Fullem, Chicago, Ill.		
C. R. Knowles, Chicago.		
R. J. McKee, Freeport, Ill.		
Samuel P. Munson, Mattoon, Ill.		
William Reed, Grenada, Miss.		
C. E. Thomas, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	1	420
G. A. Wright, Decatur, Ill.		
Indianapolis, Columbus & Southern Traction Co.	1	62
A. Shane, Columbus, Ind.		
Intercolonial Ry.	7	1,468
T. C. Burpee, Moncton, N. B.		
Hugh Jardine, Moncton, N. B.		
A. E. Killam, Moncton, N. B.		
H. J. McGrath, Moncton, N. B.		
W. B. McKenzie, Moncton, N. B.		
Thomas Sefton, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Browne, Clinton, Mo.		
Kansas City Southern Ry.	2	762
C. E. Johnston, Kansas City, Mo.		
J. J. Taylor, Texarkana, Tex.		
Lake Erie & Western Ry.	2	882
P. P. Lawrence, Tipton, Ind.		
J. N. Penwell, Tipton, Ind.		
Lake Shore & Michigan Southern Ry.	4	1,775
Willard Beahan, Cleveland, O.		
Philip O'Neill, Adrian, Mich.		
R. H. Reid, Cleveland, O.		
J. L. Soisson, Norwalk, O.		
Lake Superior & Ishpeming Ry., Munising Ry., and Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	1	96
J. E. Barrett, Warwick, N. Y.		
Lehigh & New England R. R.	1	170
W. E. Harwig, Bethlehem, Pa.		

Name of Road and Membership.	Members.	Mileage
Lehigh Valley R. R.	9	1,446
E. B. Ashby, New York City.		
Peter Hofecker, Auburn, N. Y.		
J. W. Holcomb, Buffalo, N. Y.		
Judson Joslin, Auburn, N. Y.		
David A. Keefe, Athens, Pa.		
A. E. Kemp, Hazleton, Pa.		
F. E. Schall, South Bethlehem, Pa.		
L. W. Swan, Easton, Pa.		
E. R. Wenner, Ashley, Pa.		
Long Island R. R.	4	392
W. F. O'Connor, Flushing, N. Y.		
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Louisiana & Arkansas Ry.	1	255
W. H. Vance, Stamps, Ark.		
Louisville & Nashville R. R. (and Nash. Term. Co.)	11	4,728
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Nashville, Tenn.		
H. R. Hill, Birmingham, Ala.		
Floyd Ingram, Erin, Tenn.		
J. W. Little, Birmingham, Ala.		
A. B. McVay, Evansville, Ind.		
C. M. Roy, Birmingham, Ala.		
Wm. Sheley, Evansville, Ind.		
H. Stamler, Paris, Ky.		
W. G. Stewart, Nashville, Tenn.		
Maine Central R. R.	1	1,180
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.	4	1,803
S. D. Bailey, Detroit, Mich.		
Thomas Hall, St. Thomas, Ont.		
Henry A. Horning, Jackson, Mich.		
J. T. Webster, St. Thomas, Ont.		
Minneapolis & St. Louis R. R.	2	1,586
Ed. Gagnon, Minneapolis, Minn.		
G. S. Kibbey, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	2	3,770
P. Swenson, Minneapolis, Minn.		
G. A. Manthey, Minneapolis, Minn.		
Miss. River & Bonne Terre Ry.	1	64
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Ry.	1	3,073
A. S. Clopton, Parsons, Kans.		
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.)	19	7,231
E. E. Allard, St. Louis, Mo.		
Robert J. Bruce, St. Louis, Mo.		
E. M. Dolan, St. Louis, Mo.		
A. H. Ferdina, St. Louis, Mo.		
C. Gnadt, Poplar Bluff, Mo.		

Name of Road and Membership.	Members.	Mileage
Missouri Pacific Ry. System. Continued.		
Lon Graves, Dermott, Ark.		
W. Hausgen, Sedalia, Mo.		
E. P. Hawkins, Bastrop, La.		
W. J. Lacy, Poplar Bluff, Mo.		
G. W. Land, McGehee, Ark.		
C. E. Redmond, Van Buren, Ark.		
C. E. Smith, St. Louis, Mo.		
E. A. Stanley, St. Louis, Mo.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
L. J. Wackerle, Osawatomie, Kans.		
A. L. Waits, St. Louis, Mo.		
C. H. Walther, Poplar Bluff, Mo.		
Mobile & Ohio R. R.	2	1,114
W. B. Harris, Murphysboro, Ill.		
B. F. Whiting, Murphysboro, Ill.		
Nashville, Chattanooga & St. Louis Ry.	1	1,230
I. O. Walker, Paducah, Ky.		
National Rys. of Mexico	1	6,177
Hans Bentele, Mexico City, Mex.		
New South Wales Government Rys.	1	3,472
James Fraser, Sydney, N. S. W.		
New York Central & Hudson River R. R.	10	2,829
J. K. Bonner, Rochester, N. Y.		
U. S. Hitesman, New York City.		
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		
John Schaffer, Rochester, N. Y.		
H. C. Thompson, Weehawken, N. J.		
C. C. Warne, New York City.		
E. E. Wilson, New York City.		
New York, New Haven & Hartford R. R.	11	2 091
Grosvenor Aldrich, Readville, Mass.		
J. S. Browne, Providence, R. I.		
Wm. Graham, New Haven, Conn.		
H. H. Kinzie, Taunton, Mass.		
Wm. H. Moore, New Haven, Conn.		
B. P. Phillips, Willimantic, Conn.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
D. W. Sharpe, New Haven, Conn.		
J. B. Sheldon, Providence, R. I.		
New York, Ontario & Western R. R.	1	494
J. H. Nuelle, Middletown, N. Y.		
New Zealand Government Rys.	2	2,717
C. H. Biss, Christchurch, N. Z.		
George A. Troup, Wellington, New Zealand.		

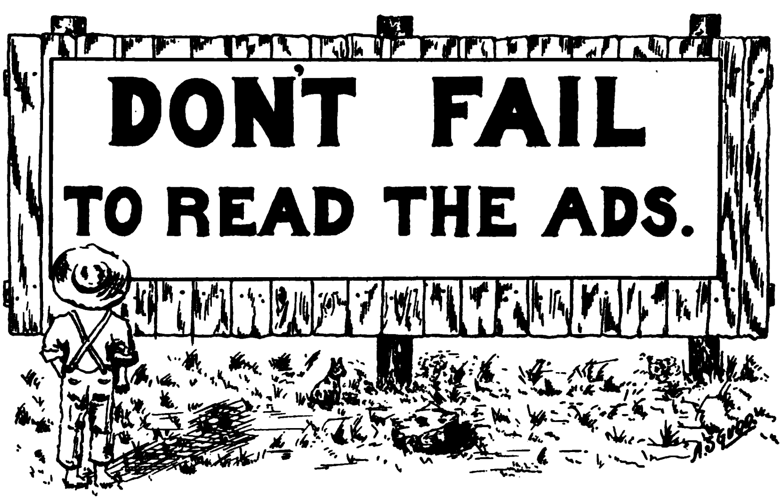
Name of Road and Membership.	Members.	Mileage
Northern Pacific Ry.	5	6,029
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
R. E. McFarlane, Duluth, Minn.		
J. C. Taylor, Glendive, Mont.		
North Western Govt. Rys. (India)	1	4,431
D. M. Cookson, Kalaw, Burma, India.		
Northwestern Pacific R. R.	1	469
A. A. Robertson, San Rafael, Cal.		
Oregon Short Line R. R.	15	1,752
D. H. Ashton, Salt Lake City.		
Robt. Barr, Pocatello, Idaho.		
J. F. Cullen, Pocatello, Idaho.		
W. C. Dale, Salt Lake City.		
J. S. Eastman, Idaho Falls, Idaho.		
O. Forsgren, Brigham, Utah.		
C. J. Harris, Idaho Falls, Idaho.		
A. H. King, Salt Lake City, Utah.		
C. T. Musgrave, Idaho Falls, Idaho.		
P. E. Parsons, Salt Lake City.		
S. J. Powell, Ogden, Utah.		
A. W. Robinson, Salt Lake City.		
R. B. Robinson, Salt Lake City.		
A. R. Stevens, Salt Lake City.		
D. T. Wells, Salt Lake City.		
Pacific Electric Ry.	1	570
D. E. Plank, Los Angeles, Cal.		
Pennsylvania Lines West of Pittsburg	8	3,098
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
J. Wallenfelsz, Cambridge, O.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	5	5,304
M. M. Barton, West Philadelphia, Pa.		
Richard G. Develin, Philadelphia, Pa.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibbon, Altoona, Pa.		
C. W. Richey, Pittsburg, Pa.		
Pere Marquette R. R.	7	2,336
J. D. Black, Saginaw, Mich.		
Edw. Guild, Edmore, Mich.		
G. E. Hanks, East Saginaw, Mich.		
A. McNab, Holland, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		
J. P. Wood, Edmore, Mich.		

Name of Road and Membership.	Members.	Mileage
Philadelphia & Reading Ry.	4	1,481
Amos H. Beard, Reading, Pa.		
John Foreman (retired), Pottstown, Pa.		
E. G. Storck, Philadelphia, Pa.		
E. E. Templin, Pottsville, Pa.		
Pittsburg & Lake Erie R. R.	2	215
D. L. McKee, McKee's Rocks, Pa.		
G. H. Soles, Pittsburg, Pa.		
Queen & Crescent Route	1	509
E. L. Loftin, Vicksburg, Miss.		
Quincy, Omaha & Kansas City R. R.	1	261
T. F. DeCapito, Milan, Mo.		
San Pedro Los Angeles & Salt Lake R. R.	4	1,075
F. M. Bigelow, Salt Lake City, Utah.		
R. R. Bishop, Salt Lake City.		
W. C. Frazier, Los Angeles, Cal.		
D. W. Scannell, Salt Lake City.		
Seaboard Air Line Ry.	8	3,046
W. M. Barker, Scotia, S. C.		
B. B. Christy, Tallahassee, Fla.		
W. J. Gooding, Jr., Savannah, Ga.		
B. Land, Jr., Jacksonville, Fla.		
W. A. McDearmid, Tallahassee, Fla.		
J. C. Nelson, Portsmouth, Va.		
G. B. Smith, Jacksonville, Fla.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	2	319
O. H. Andrews, St. Joseph, Mo.		
Wm. Carmichael, St. Joseph, Mo.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis.		
St. Louis, Rocky Mt. & Pac. R. R.	1	106
Alf Brown, Raton, N. M.		
St. Louis Southwestern Ry.	2	1,451
J. S. Berry, St. Louis, Mo.		
Wm. Quinn, Tyler, Tex.		
Southern Ry.	14	7,090
D. A. Ballenger, Greenville, S. C.		
J. H. Blackwell, Charleston, S. C.		
H. S. Douglass, Charleston, S. C.		
W. F. Fraylick, Charleston, S. C.		
J. R. Fowlkes, Columbia, S. C.		
N. L. Hall, Greensboro, N. C.		
Joseph A. Killian, Jr., Charlotte, N. C.		
J. S. Lemond, Charlotte, N. C.		
J. W. Morgan, Columbia, S. C.		
C. A. Redinger, Charlotte, N. C.		
T. E. Sharpe, Greenville, S. C.		
J. B. Teaford, Lawrenceburg, Ky.		
G. W. Welker, Alexandria, Va.		
A. A. Wells, Winston-Salem, N. C.		

Name of Road and Membership	Members.	Mileage
Southern Pacific Company,	54	6,663
C. J. Astrue, Oakland Pier, Cal.		
T. W. Bratten, West Oakland, Cal.		
H. Bulger, Oakland Pier, Cal.		
W. H. Burgess, Stockton, Cal.		
D. Burke, Tucson, Ariz.		
W E. Burns, Portland, Ore.		
J. T. Caldwell, Bakersfield, Cal.		
W. S. Corbin, Los Angeles, Cal.		
G. S. Crites, Los Angeles, Cal.		
D. M. Crosman, Los Angles, Cal.		
L. V. Degnan, Oakland Pier, Cal.		
Geo. Dickson, Oakland, Cal.		
R. M. Drake, San Francisco.		
B. F. Ferris, Los Angeles, Cal.		
J. F. Fisher, Sacramento, Cal.		
M. Fisher, Ogden, Utah.		
A. Fraser, Bakersfield, Cal.		
Neil Fraser, Salem, Ore.		
P. Fritz, Los Angeles.		
Ira Gentis, Oakland, Cal.		
J. A. Givens, Sacramento, Cal.		
Jas. Gratto, Los Angeles, Cal.		
C. F. Green, Sacramento, Cal.		
P. Guisto, San Francisco.		
W. C. Harmon, Bakersfield, Cal.		
J. Hubley, Colfax, Cal.		
C. A. Jensen, Los Angeles.		
A. W. Lasher, Suisun, Cal.		
T. J. Linehan, Ventura, Cal.		
H. Lodge, San Francisco.		
J. B. Malloy, San Francisco.		
J. D. Mathews, Tucson, Ariz.		
F. D. Mattos, W. Oakland, Cal.		
M. J. Mayer, San Francisco, Cal.		
C. W. McCandless, Ventura, Cal.		
D. McGee, Sacramento, Cal.		
A. M. McLeod, Oakland, Cal.		
E. C. Morrison, San Francisco.		
J. J. Murphy, Oakland, Cal.		
P. N. Nelson, San Francisco, Cal.		
Harry Pollard, San Francisco, Cal.		
Homer Pollard, West Oakland, Cal.		
Geo. W. Rear, San Francisco, Cal.		
Norman Rose, Portland, Ore.		
W. M. Rose, Sacramento, Cal.		
J. S. Replogle, Oakland, Cal.		
D. T. Rintoul, Bakersfield, Cal.		
A. L. Robinson, Stockton, Cal.		
Niles Searls, San Francisco, Cal.		
F. M. Siefer, Portland, Ore.		
E. J. Vincent, Los Angeles.		
A. Weldon, Bakersfield, Cal.		
I. G. Wiley, Dunsmuir, Cal.		
M. M. Wilson, Los Angeles, Cal.		
Tennessee, Alabama & Georgia R. R.	1	98
C. H. Fisk, Chattanooga, Tenn.		
Texas & Pacific Ry.	1	1,885
E. Loughery, Marshall, Tex.		

Name of Road and Membership.	Members.	Mileage
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Toledo Railways & Light Co.,	1	110
A. Swartz, Toledo, O.		
Union Pacific R. R.,	1	3,574
J. Parks, Denver, Colo.		
Vandalia R. R.	1	829
J. L. McKee, Spencer, Ind.		
Virginian Ry.,	1	444
P. W. Cahill, Roanoke, Va.		
Wabash R. R.	2	2,514
A. O. Cunningham, St. Louis, Mo.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.	2	53
W. M. Cardwell, Washington, D. C.		
C. H. Spencer, Washington, D. C.		
Wellington & Manawata Ry. (New Zealand)	1	84
Arthur Williams, Wellington, New Zealand.		
Western Australia Government Rys.	2	1,943
W. J. George, Perth, Western Australia.		
E. S. Hume, Midland Jct., Western Australia.		
Western Pacific Ry.	3	934
T. J. Stuart, Elko, Nev.		
M. R. Krutsinger, Sacramento, Cal.		
Norton Ware, San Francisco.		
Wheeling & Lake Erie R. R.	2	496
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
Total Members and Mileage,	470	231,967
Members not with Railroads,	54	
Total Membership,	524	

INDEX TO ADVERTISEMENTS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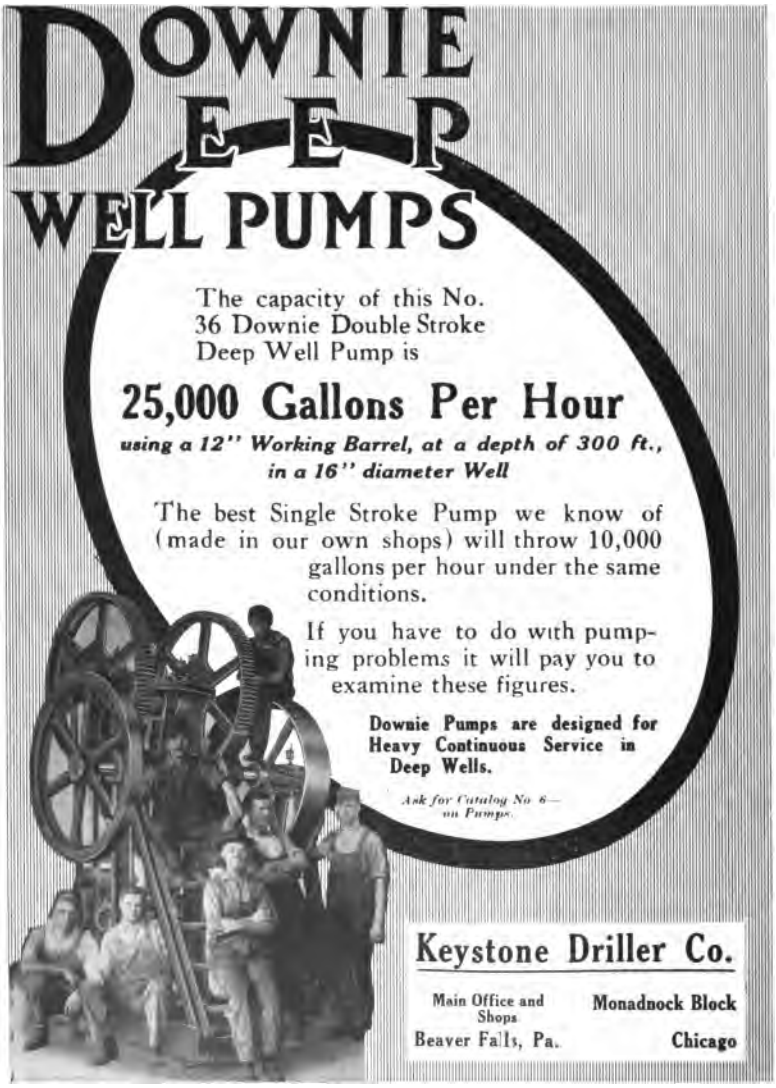
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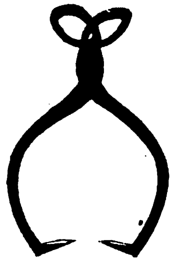

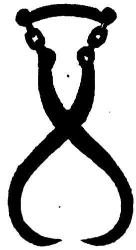

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